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THE SURGICAL TREATMENT OF ACUTE CHOLECYSTITIS AND COMMON DUCT OBSTRUCTION

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FIFTEEN years ago Enderlen and Hotz, from collective statistics of 12,000 cases of gall-bladder operations, advised the earliest possible operation in young patients in order to improve the operative results. At that time, it was the general practice not to operate during the acute attack, but to wait until the acute symptoms had subsided before performing the radical operation. It is remarkable that not only internists but also excellent surgeons, e.g., Haberer, even now follow this rule and advise operation only when symptoms of acute pancreatitis or peritonitis develop. This point of view was founded by Metzler, a pupil of Haberer's, because the mortality of the operation during the acute attack in elderly patients amounted to 44 per cent as compared with 8 per cent during the interval between attacks. It is true that, if, with this conservative point of view, the operation finally becomes absolutely necessary during the acute attack, the mortality increases more and more, and therefore the fear of operation during the acute attack on the part of the surgeon is increased. I intend to prove that one may break this vicious circle by early operation during the acute attack.

The opponents of operation during the acute attack with fever pretend that the operation is too dangerous and its mortality too high; therefore, it may not be recommended as the operation of choice. The mortality depends upon many factors; the operation itself is the least important. The condition of the gall bladder and the extension of the inflammation to the neighboring organs are of greatest importance. When the inflammation is restricted to the gall bladder, as is the case during the first or second day of the attack, the results are good, even with elderly patients. Therefore, early operation during the acute

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attack may reduce the mortality markedly. Krüger, a German surgeon, in 1929 reported his results of operations performed during acute gallstone attacks with fever. The early operations had a mortality of 1.2 per cent in 249 cases; whereas, in 50 late operations the mortality rose to 28 per cent. Graham in 198 cases of acute cholecystitis had no deaths with early operation while the disease was still restricted to the gall bladder.

It has been my practice for more than twenty years to operate early during the acute attack. The results are good and all the dangers of postponing the operation are avoided. In cases of young people having the first acute attack, when the diagnosis is not absolutely certain, one may wait rather than operate as in the case of older patients. Nevertheless, even with young patients one is never sure whether a second attack may not be fatal. Let me report an example:

Ten years ago I operated upon a 29-year-old woman on the fifth day of her second gallstone attack. She had demanded the operation during the first attack five months previously because she had had relatives who had died following delayed operation, but the attending doctors had advised against operation. I saw the patient on the fifth day of the acute attack of common duct obstruction; she had fever and jaundice. An internist had urgently advised operation because of acute pancreatitis. The cause of the obstruction was a stone wedged on the papilla, which caused the acute pancreatitis. I was able to remove the stone only after transduodenal choledochotomy. Despite the operation, the pancreatitis progressed. The patient died thirty-six hours later, protesting that she would not have died if she had been operated upon during the first attack, as she had requested.

Of greatest importance is the early operation during the acute attack in patients over 60 years of age, because experience shows that in these cases the gall bladder quickly becomes gangrenous and perforates. While gangrene of the appendix, also a very frequent occurrence with elderly individuals, is accompanied by a characteristic acceleration of the pulse and often a normal temperature; on the other hand, this increased pulse rate does not appear as frequently in cases of gangrene of the gall bladder, so that, apart from the local point of tenderness, there is scarcely any symptom until suddenly perforation occurs. Therefore, one can understand why in these cases one rarely makes the diagnosis before operation, as illustrated by the following case:

Five years ago I operated upon a 65-year-old man who had never been ill. Forty-eight hours previously he had become ill with indefinite abdominal pain. The patient had no stools, no flatus; therefore, he was sent to the hospital with the diagnosis of intestinal obstruction. Temperature was normal; pulse, 80; but his right hypochondrium very tender on pressure. Therefore I gave the diagnosis of paralytic intestinal obstruction due to acute cholecystitis. I advised an immediate operation, which was performed with splanchnic anesthesia and showed to my surprise a perforation of a gangrenous gall bladder and peritonitis, owing to lack of adhesions. There was no stone in the gall bladder. Cholecystectomy with drainage was carried out. A bile fistula persisted for a long time.

I have noticed acute gangrene in 14 cases during early operation and have been able to avoid the perforation peritonitis by the operation. This is very important with older patients. Among these patients the only fatality was that of a 77-year-old man who had, in addition to the gangrenous gall bladder and threatening perforation, a cancer of the pancreas as big as a fist. He died on the fifth day from cardiac insufficiency. All the other patients were cured.

TABLE I

ACUTE CHOLECYSTITIS

	EARLY OPERATION		LATE OPERATION	
	NUMBER	MORTALITY	NUMBER	MORTALITY
Krüger	249	1.2%	50	28.1%
Finsterer	62	3.2%	97	7.2%

The results of the early operations, when the gangrenous gall bladder was removed, were satisfactory. Among 62 cases, apart from the 77-year-old man, a second death, that of a 50-year-old man from pulmonary embolus, is recorded. It is most important in older patients to eliminate wholly the ether narcosis and to operate only under local or splanchnic anesthesia. Among 19 patients between 60 and 79 years of age, only the above-mentioned 77-year-old man died; all others were cured, including 6 patients over 70 years of age.

When the patients come to operation only after unsuccessful medical treatment for the acute attack, the results of such late operation are not as good; but, nevertheless, they are better than with continued medical treatment with the hope of reducing the symptoms and operating during the interval. In 1932 Mentzer reported that of 134 cases of acute cholecystitis at the San Francisco Hospital, 63 cases were treated medically, with a 56 per cent mortality; while 71 cases, which were finally operated upon because of increasing symptoms, showed 25 per cent mortality.

Certainly also with very serious cases occasionally spontaneous healing is possible by perforation of the abscess into the transverse colon. In this way a gangrenous gall bladder may be eliminated spontaneously so that one finds later no gall bladder at all, but only adhesions. Of course, this advantageous event is possible only if there were, owing to repeated attacks, sufficient protecting adhesions formed which prevented the large abscess from perforating into the abdominal cavity under great tension. Stavaki and Veismann, two Russian surgeons, reported 2 cases where they found, upon incising a large subhepatic abscess, the whole gangrenous gall bladder free in the abscess. On my ward a similar case of an abscess incision was observed by chance.

Twenty-four years ago I operated upon a 58-year-old man because of severe duodenal stenosis due to scar. Eight years previously he had undergone a prolonged, feverish gallstone attack, with formation of an abscess. Finally he became so ill that

operation was deemed impossible by the attending internist. Healing had taken place by discharging pus with the stool. At the operation (gastroenterostomy) I intended also to remove the gall bladder, but could not find it. There was only scar tissue above the dilated common duct, although the gall bladder was repeatedly palpable during the preceding attacks as a painful tumor. In this case, there being no ulcer, permanent relief was obtained by simple gastroenterostomy. The patient is now 82 years of age.

When the inflammation is confined to the gall bladder or an abscess forms about the gall bladder, satisfactory results may be obtained with the late operation even with older patients. I have had 7 deaths among 97 cases (7.2 per cent mortality). Among these deaths there was a 71-year-old woman whose gangrenous gall bladder had already perforated into the duodenum. The duodenum was sutured and a cholecystectomy performed, but a duodenal fistula developed; therefore, jejunostomy was done six days later; nevertheless, death from inanition occurred. On a 73-year-old inebriate (the patient had drunk 1 to 2 liters of wine daily for thirty years) in bad general condition sent to operation after a week with peritoneal symptoms (temperature, 103° F.; pulse, 128; emphysema of highest degree) I found a phlegmon of the gall bladder before perforation; moreover, there was an advanced alcoholic liver cirrhosis. The patient died from insufficiency of the heart. Another patient died of uremia. Two patients, one of whom was a woman weighing 275 pounds, died from obesity and insufficiency of the heart; one death was due to pancreatitis.

The opponents of operation during the acute attack assert that the risk of peritonitis is too great, operation therefore being contraindicated. By operating cautiously and carefully walling off by compresses the field of operation from the free abdominal cavity before the cholecystectomy, one easily may avoid the fatal peritonitis. Up until now I have not seen one death from diffuse peritonitis in a series of 161 cases operated upon during the acute attack, although in 13 cases a big abscess near the gall bladder was found. Smith, of New York City, did not have a death from peritonitis in 107 acute cases. Krüger had only one death from peritonitis among 249 cases. Coming upon a large abscess immediately after cutting through the abdominal wall, the surgeon will content himself with simple incision. In these cases there remains quite often a bile fistula. I have operated upon 15 cases in such a way without any death; they are not included in these statistics. Finding an abscess near the gall bladder after opening the abdominal cavity and packing the field of operation, while severing the adhesions, one may remove the gall bladder without any risk. I have never seen any damage result from this procedure; diffuse peritonitis has never occurred, but I always leave in a drain.

It is an important question whether cholecystectomy is preferable to cholecystostomy. The drainage of the gall bladder after removal of the stones is certainly technically easier than cholecystectomy;

TABLE II

TYPE OF OPERATION

	CHOLECYSTOSTOMY		CHOLECYSTECTOMY	
	NUMBER	MORTALITY	NUMBER	MORTALITY
Pratt	22	10 (45%)	23	0
Finsterer	9	4 (44%)	152	5 (3.2%)

nevertheless, its mortality is higher because an intensely inflamed organ is left in the abdominal cavity from which the inflammation may spread to the deep bile ducts and, above all, to the pancreas. I have carried out cholecystostomy only 9 times, and then because the attendant internists were absolutely opposed to the extirpation of the gall bladder. Of these, 4 cases died. Especially important is the following case:

A 58-year-old woman was operated upon on the fourth day of the acute attack. She was unconscious, with a temperature of 103° F.; pulse, 130. I found a phlegmon of the gall bladder with malodorous pus but no adhesions. Although the gall bladder was freely movable and therefore cholecystectomy would have been very easy, I left the gall bladder because the internist present at the operation was absolutely opposed to cholecystectomy. Therefore, only the stones were removed and the gall bladder and its vicinity were drained. The early postoperative course was good. The patient passed stools and flatus on the second day and had a normal pulse. On the ninth day there was an increase of the pulse rate and pain in the left epigastrium, such as occur in cases of acute pancreatic necrosis. On the eleventh day there was exitus from progressive pancreatic necrosis. At the operation the pancreas had been normal, without even edema; infection ensued only later. In this case cholecystectomy certainly might have saved the patient.

The results of cholecystectomy are good also in cases of acute cholecystitis, for among 152 cases there were only 5 deaths (3.2 per cent mortality). Also, Pratt had a similar experience with acute cholecystitis. While 23 cases of cholecystectomy were all cured, there were 10 deaths among 22 cholecystostomies (45 per cent mortality). Therefore, cholecystectomy can be recommended as the method of choice also during the acute attack.

The internists always assert that the dangers of operation during the acute attack are much greater than the risks of medical treatment, but this contradicts the above-cited communication of Mentzer's from the San Francisco Hospital where medical treatment of acute cholecystitis had a 56 per cent mortality and the late operation, but 25 per cent. It was advised to perform the operation only if absolutely necessary because of diffuse peritonitis or acute pancreatitis. But the diagnosis of perforation peritonitis is particularly difficult, because there is usually no perforation pain similar to that in perforation of an ulcer; on the contrary, immediately after perforation patients even feel some relief because the painful tension of the gall bladder ceases with the emptying of its contents. Also, the accelera-

tion of the pulse takes place very late. If the common duct is blocked, much bile flows into the abdominal cavity; the pulse rate is not accelerated. By the resorption of the bile, it may come to bradycardia, rendering the diagnosis difficult, just as when the bradycardia appearing after hepatic injuries, the diagnostic importance of which I pointed out twenty-five years ago, makes the diagnosis of acute hemorrhage impossible. Therefore, such patients with perforation peritonitis come too late to operation; recovery is to be expected at best only in young patients. I have had 5 recoveries among 11 cases of perforation of the gall bladder with diffuse peritonitis; among these was a 71-year-old woman who, three months later, had a perforated gangrenous appendix, with diffuse peritonitis, from which she also recovered.

Much more dangerous is the spread of the inflammation to the pancreas and the development of acute pancreatic necrosis. In the literature, it is true, some recoveries are reported. Thus, Orator and Straaten report 8 recoveries among 18 cases at Haberer's clinic. I myself have lost all of my 7 cases of acute cholecystitis and pancreatic necrosis, despite operation and regardless of whether the gall bladder was removed or, owing to the bad general condition, only drained. In the literature one continues to find reports of recoveries despite a simultaneous pancreatitis. To be sure, these are cases of the so-called first stage of the acute pancreatitis, of edema of the pancreas, which I also observed in cases of acute phlegmonous gall bladder; but, as it is a simple collateral edema which can be found about every inflammation, I did not include it among the cases of acute pancreatitis.

When with more prolonged acute inflammation not only an abscess near the gall bladder is formed and ascending infection of the bile ducts with chills is started, but also septicemia is to be diagnosed because bacteria (streptococci, staphylococci) are found repeatedly in the blood; by then the operation is too late, for by the operation we may remove the primary focus, but we cannot cure the septicemia. Whether, after extirpation of the diseased gall bladder, the organism can overcome the already present infection cannot be predicted. Because such a patient perhaps can be cured only by the cholecystectomy, I attempt the operation, even if, as my own observations show, the operation may not be successful.

By the early operation in acute cholecystitis, not only we may reduce the immediate operative dangers and prevent fatal complications but also by the cholecystectomy we may relieve the patients permanently from their complaints. At re-examination of all patients operated upon because of gallstones, I noticed four years ago that the best permanent results were obtained by cholecystectomy during the acute attack. In 142 cases where the interval operation was carried out from four to twenty-two years previously, there were 13.5 per cent

failure of complete cure. Of these, 2.8 per cent were due to cholangitis; the others suffered from colitis or duodenal ulcer.

TABLE III

PERMANENT RESULTS OF CHOLECYSTECTOMY

	CHRONIC CHOLECYSTITIS	ACUTE CHOLECYSTITIS
Cured	142 (79.7%)	64 (91.4%)
Improved	12 (6.7%)	4 (5.7%)
Failure	24 (13.5%)	2 (2.8%)
Total	178 cases	70 cases

In 70 cases where operation was carried out during the acute attack, 64, or 91.4 per cent, were well for periods ranging from four to twenty years postoperatively. Four cases are suffering from slight hyperacidity, but they are content with the result of the operation, as they are relieved of their severe pain. There are, thus, 97.1 per cent satisfactory results.

On one uncured patient who suffered a chronic cholangitis, I performed a choledochoduodenostomy, and this patient has been well for ten years. In the second uncured case there was a duodenal ulcer complicated by massive hemorrhage. Since a radical gastrectomy twenty-two years ago, this patient has been perfectly well.

From my experience with the operation performed during the acute feverish gallstone attack, in opposition to the hitherto prevailing opinion, I should recommend the early operation during the acute attack as the most reliable method of treatment, which, by eliminating the ether narcosis, considerably reduces the operative mortality, avoids the risks of a later complication, and, by the removal of the diseased gall bladder, delivers the patient wholly and permanently from any complaint in more than 90 per cent of the cases.

The common duct obstruction by a gallstone is a very serious complication. The medical treatment is of long duration and uncertain success, and the surgical treatment is feared by most practitioners and internists because of its ostensibly great dangers, so that the patients are sent to operation only with absolutely urgent indications. The internists' and surgeons' opinions concerning the best time for operation are divided. While most surgeons ask for the earliest possible operation, the internists prefer waiting at least four to six weeks in the hope that the stone will pass through the papilla. They base this hope upon the observation of cases where jaundice disappeared after a few days' treatment, a fact they explain by the passing of a stone through the papilla. I will not contest the possibility that a little stone may pass through the papilla; also I will agree that regular rinsing of the duodenum with sulfate of magnesia renders good service on application of the duodenal tube accompanied by a prescription containing an antispasmodic. The results of such treatment can be

determined in one to two weeks. With this method I have seen really good results, so that the operation could be avoided. Therefore, within the first weeks, when fever or chills are wanting, I recommend an attempt with the duodenal tube, but I advise an operation if no result is obtained after two weeks of treatment.

When jaundice with wholly acholic stools accompanying the acute gallstone attack disappears after some days, with the decrease of the pains, there is no proof that in such a case a stone has passed out through the papilla. It is much too little appreciated that a complete common duct obstruction can occur without any stone in the duct. This obstruction results from the following circumstances: the cystic duct is obturated by a stone during the acute gallstone attack; the enormously strained gall bladder, its head fast fixed on the liver bed and therefore not able to extend itself forward, distends itself on its neck; the common duct lying beneath is so thoroughly compressed between gall bladder and vertebral column that no bile passes at all. This state can indisputably be found during operation for an acute attack. After emptying the overdistended gall bladder by puncture, the pressure on the common duct is completely relieved and the bile flows at once into the duodenum and stomach and may be vomited. This manner of common duct obstruction I could ascertain without doubt in 13 cases as follows: Some patients who before had wholly acholic stools vomited bile after the puncture of the gall bladder; at choledochotomy no stone was found and the papilla was permeable. One cannot suppose that quite incidentally, not in 1 case but in 13 cases, the stone passed through the papilla, just at the moment of the operation made with local anesthesia; one can never pretend that the stone occluding the papilla, upon decrease of the tension, owing to the puncture of the gall bladder, no longer was pressed against the papilla, the discharge of the bile thus being possible again; but that the stone could not be found in the common duct by any means at the following examination. All the patients have remained, from the operation until now (that is, for a period of twelve years), free from any complaints, a condition which would be impossible if a so-called pendulum stone were left in the common duct.

A similar event occurs in the successful medical treatment of the gallstone attack. By means of an antispasmodic the tension of this overdistended gall bladder relaxes, the pressure upon the obturating stone in the neck of the gall bladder ceases, and with the slightest movement bile can flow off; the gall bladder empties itself through the cystic duct, whereby the pressure upon the common duct ceases. With the decrease of pain and cessation of the attack, there is a disappearance also of the jaundice caused by compression of the common duct and not by a stone in the common duct. If the stools remain acholic after cessation of the attack, there is a stone obturating the

papilla; the occlusion may be loosened by regular duodenal washings, owing to which the spasm of the sphincter Oddi ceases, the papilla distends itself, and the stone, if it be not too large, passes. For this purpose, a treatment of one to two weeks is sufficient. If the occlusion persists, there is usually a big stone that can pass into the duodenum only after forced dilatation and rupture of the papilla or after a decubital ulcer of the papilla has perforated into the duodenum. These are the cases in which one finds at operation during the interval after previous jaundice that the papilla is narrowed; despite the dilatation of the papilla, colic occurs after the cholecystectomy. These attacks of colic are clinically explained by common duct stones overlooked or formed afresh, while relaparotomy shows only a dilated common duct with muddy bile, a narrowed papilla, but no stone. These cases are curable permanently only by a choledochoduodenostomy.

If the common duct obstruction is accompanied by fever and chills, according to my opinion one has to operate as soon as possible to prevent ascending infection of the bile ducts and formation of liver abscesses; or, if these conditions already are present, to cure them by restoration of free bile discharge. Within the first weeks, fever may be explained by mere cholecystitis; there may not be even a stone obturation of the common bile duct, as was shown above. Denk advises in cases of jaundice with fever to combat the infection first by medical treatment and to remove the obstruction by operation only after decrease of the fever; he has had a higher mortality when he operated upon these cases in the first weeks than when he operated for common duct obstruction without fever after two months or more. I cannot agree with this suggestion. Only if the jaundice is caused by compression of the common duct and the fever by purulent cholecystitis, can one perhaps expect success by conservative treatment. With stone obstruction and ascending infection, the cure of the infection is impossible without simultaneous removal of the occlusion. The patients at last become so feeble by the permanent fever and chills that operation is then declined; they die without operation, just as the patient refusing the operation, as the internist Eppinger, one of the best experts of liver disease, has hinted in his book on liver diseases published a year ago.

If, according to the internists' proposal, the operation is postponed for four to six weeks or more, the dangers of operation are increased because of the progressing liver damage, ascending infection of the bile ducts, and cholemic postoperative hemorrhage. The mortality will be higher with these late operations, just as with acute cholecystitis. If one intends to obtain any success in such advanced cases, he must act according to these three factors. On account of the already existing liver damage, any further damage of the liver absolutely must be avoided. The liver must not be traumatized by retrac-

tion during the whole operation, even though the operation is rendered a little more difficult, because in this stage the liver is particularly sensible to any trauma. I regard rolling of the liver out of the abdominal cavity over the costal arch as especially dangerous; therefore, I never have used this procedure in my gall-bladder operations. Also, ether narcosis must be wholly eliminated. We know today that ether is a dangerous liver poison whose toxicity increases with the quantity and concentration of the ether used. Crile, in his excellent book on *Surgical Shock and Shockless Operation Through Anoci-Association,* has proved this by many animal experiments. He also has shown that nitrous oxide does not exert the same toxic effects. While the normal liver recovers from this toxic process in a short time, a liver already injured by disease becomes incapable of recovery, owing to summation of the damages. The result is death from insufficiency of the liver, often called simple shock death. For the past twenty-five years I have operated upon cases of common duct obstruction only under local anesthesia of the abdominal wall and splanchnic or paravertebral anesthesia and have no death to report from insufficiency of the liver, despite many critical cases. I suppose that my good operative results are due to the avoidance of deep ether narcosis.

For combating the postoperative hemorrhage in jaundiced patients, different methods have been suggested, the efficiency of which is not generally acknowledged. It is easy to understand that blood transfusions before and after the operations are advantageous, even if only for substituting the lost blood and for the lesser effect on the blood coagulation. For fifteen years I have made prophylactic x-ray irradiation of the spleen with ⅓ E. D., according to the suggestion of an Italian surgeon, in order to increase the blood coagulation. The irradiation must be made immediately before the operation, for, if too long a time should elapse between the irradiation and the operation, the desired effect on the coagulation time may be at its height during the operative procedure. This results in imperfect hemostasis at the operation and the occurrence of postoperative hemorrhage. Fifteen years ago I saw this happen in a case of jaundice caused by cancer of the pancreas which had been irradiated twenty hours before the operation. During the operation, there was remarkably little bleeding in spite of normal blood pressure; twenty-four hours postoperatively, hemorrhage set in. Since then I have made the irradiation immediately before the operation. The real effect of the method is difficult to prove; still, these last fifteen years I have seen only two deaths from cholemic postoperative hemorrhage; in one case there had been previous irradiation, while, in the other, the irradiation of spleen was technically impossible. I consider it more important to avoid the external drainage of the common bile duct in these cases and to drain the bile directly into the intestine by choledochoduodenostomy. The Russian surgeon Grekow

once suggested that cholemic hemorrhages are not caused by the presence of bile in the blood but by deficiency of bile in the intestines; therefore, one ought to bring the bile as soon as possible into the intestines. This assertion would be supported by the researches of Graves and Schmidt, who, in cases of bile deficiency in the intestines, noticed a decreased absorption of the vitamin D which is stored in the liver and which reduces the time of blood coagulation. Because of my performing mostly choledochoduodenostomies, freedom from cholemic postoperative hemorrhage may be the result of the advantageous effect of the internal biliary drainage.

The ascending infection of the bile ducts is most effectually combated by stimulation of the bile secretion after the operation and by free discharge of the bile. To achieve this, cholagogues of all sorts are used. Their administration immediately after the operation, however, is rendered difficult. In such cases I use decholin, introduced into the therapeutics of gallstone disease by Neubauer. Patients receive, when highly feverish, an intravenous injection of 10 c.c. decholin (20 per cent dehydrocholic sodium) on the second day after operation; the injection is repeated within the following two to three days until the fever decreases. Later, medical remedies may be applied.

The removal of the stone responsible for the obstruction usually is not sufficient to ensure free bile drainage into the duodenum, because the flow temporarily may be interrupted owing to swelling of the papilla and spasm of the sphincter of Oddi. Therefore, in these cases one has to eliminate at least the function of the sphincter by forced dilatation of the papilla, as performed by Bakes, Walzel, and other surgeons. A free drainage is better obtained by common duct drainage or by choledochoduodenostomy. The common duct drainage is surely the more simple operation, but its mortality is of a high degree, because the patients obviously do not tolerate well prolonged bile loss and the risk of postoperative hemorrhage increases. Friedrich reports that at Hoch-

TABLE IV

COMMON DUCT OBSTRUCTION

MORTALITY

	COMMON DUCT DRAINAGE		CHOLEDOCHODUODENOSTOMY	
	NUMBER	MORTALITY	NUMBER	MORTALITY
Jurasz	73	20.5%	47	4.2%
Finsterer	22	5 (22.7%)	62	6 (9.6%)

enegg's clinic the mortality of the common duct drainage amounted to 32 per cent; at Haberer's, 28 per cent. Jurasz with common duct drainage had a 20.5 per cent mortality among 73 cases, while among 47 cases of choledochoduodenostomy only a 4.2 per cent mortality occurred. During my first years in practice, I also applied the common duct drainage, but during the last twenty years I have been using it very infre-

quently, its mortality, compared with choledochoduodenostomy, being of a high degree; among common duct drainages I have had 5 deaths (22.7 per cent) and in addition 3 late deaths from inanition due to a persisting bile fistula, so that the mortality is exactly 36.3 per cent. Surely with these 3 deaths, all in cases operated upon before the War, deaths from bile fistula could have been prevented by choledochoduodenostomy, which at that time I did not know. The choledochoduodenostomy, however, has a 9.6 per cent mortality (62 cases with 6 deaths), although there were many very severe cases; in 32 cases the common duct obstruction had lasted two to twelve months; in 36 cases there was moreover purulent cholangitis with high fever and chills; 39 patients were 60 to 79 years old. Among these 6 deaths, 2 were due to bile peritonitis, avoidable by better technique; 2 were caused by cholemic postoperative hemorrhages. A 72-year-old patient with advanced arteriosclerosis died the ninth postoperative day from insufficiency of the heart and pneumonia. At the post mortem the abdomen was all right. A 69-year-old patient came to operation with chills and high fever. I found empyema of the gall bladder and purulent bile in the common duct, but no stones. The patient died after four days. The post mortem showed intense bilateral purulent bronchitis, acute dilatation of the heart, acute splenitis, purulent cholangitis, and multiple liver abscesses, especially in the right lobe. The anastomosis was all right; there was no peritonitis.

The choledochoduodenostomy can be made transduodenally with splitting of the sphincter or above the sphincter. This method was only seldom applied, despite the recommendation of Lorenz and Moszkowicz, because its mortality is high (more than 20 per cent) and it is particularly dangerous in cases where the common duct is not lying close to the duodenum but is passing up to the papilla across the pancreatic tissue. In such cases, after incising the pancreatic tissue, it may be difficult to control the hemorrhage, but above all an acute pancreatitis is almost unavoidable. Therefore, I have applied the transduodenal choledochoduodenostomy only if the stone wedged on the papilla could not be pushed higher even after mobilization of the duodenum. I have had 1 death among 5 cases.

A 47-year-old woman suffered for two and one-half months with complete obstruction of the common bile duct and petechiae. Despite preparation and blood transfusion before and after the operation, postoperative hemorrhage occurred. Two further transfusions, however, controlled the hemorrhage. The patient died, however, from acute pancreatitis.

The permanent results in the cases of transduodenal choledochoduodenostomy are excellent. Three cases are without any complaint after sixteen to seventeen years; one woman has gained 27.27 pounds in weight. The results of one case remained unknown.

In performing a supraduodenal choledochoduodenostomy, an incision 2 cm. long is made in the common duct, starting at the junction of the cystic and common ducts and extending distally; an incision of similar length is made in an appropriate area in the upper border of the duodenum. A two-layer anastomosis with interrupted sutures is carried out; the anastomosis is then covered with omentum; laterally to the anastomosis a drain is placed so that, in case there be a leak in the suture line bile will not then drain into the abdominal cavity. Moreover, the patient is placed for at least forty-eight hours in high Trendelenburg position. The anastomosis has to be sufficiently wide and must remain broadly open in order that the discharge of bile is unhindered. For this reason the transverse incision of the common duct applied by Sasse and Heyrovsky often failed. Through the wide anastomosis the bile will drain freely and thus cure sometimes even the worst cases of purulent cholangitis with superficial liver abscesses. Two examples follow:

A 75-year-old woman for three months suffered pain, fever and vomiting; for two months, jaundice with acholic stools, daily fever 102 to 103°, chills, vomiting up to twenty times a day, advanced emaciation and debility; finally a necessarily late operation was declared impossible by five internists and was refused by two surgeons. Because of the special requests of her children to attempt at least to save her life, the patient was operated upon May 29, 1927. For the local and splanchic anesthesia only ¼ per cent novocain solution was used. The cecum and appendix were found to be adherent to the gall bladder. Upon performing appendectomy, a thickened gall bladder covered with fibrin and containing many stones was found; the common duct was more than 3 cm. wide and contained a big obturating stone on the papilla and many small stones; the liver was large, surprisingly soft, and contained on its surface multiple small abscesses. Cholecystectomy and choledochotomy were performed after removal of the stones from the common duct; only pus was drained; a 2 cm. wide choledochoduodenostomy was performed. The first two days there was repeated vomiting, for which the stomach was rinsed. Fever continued and decholin intravenously was given. The fever slowly decreased. The patient recovered with increase of weight up to the normal and is without any complaint at the present date. She is now 86 years old. At the x-ray examination the bile ducts were found to be filled with barium only when the patient had been lying down for a long time on her right side.

A 70-year-old woman had had gallstone attacks for fourteen years. For the last year there had been a great many attacks and repeated jaundice. For three months there was complete obstruction of the common duct with fever: for one week, daily chills, high fever, repeated vomiting. Operation was declined by two surgeons. At her daughter's explicit request, the patient was admitted to the hospital for operation almost moribund. Temperature was 104°; pulse, 132, small and irregular; abdomen, distended and everywhere very tender to pressure. Operation was performed May 25, 1928. Because of the patient's unconsciousness and restlessness, the operation was begun under nitrous oxide narcosis, with local anesthesia of the abdominal wall; later splanchnic anesthesia was administered and the nitrous oxide was discontinued. Laparotomy was performed along the costal arch. There was a large amount of purulent bile between the right diaphragm and liver and also in the lower abdomen, without a perforation being found; the thickened gall bladder contained no stones; the common duct and hepatic duct were considerably dilated and contained a big stone wedged in the ampulla and twenty-nine small stones; the liver was enlarged,

was surprisingly soft, and on its surface had many small abscesses. Cholecystectomy and choledochotomy were performed; after removal of the obturating stone and the small ones, only pus flowed from the common duct. A 2 cm. wide choledochoduodenostomy was performed. During the first two days, the patient was still unconscious and passed almost no urine (50 c.c. within twenty-four hours) despite infusions of sodium chloride; high fever continued. From the second day intravenous injections of decholin were given with gradual decrease of the temperature; healing was retarded by persistent infection of the abdominal wall. There was a postoperative weight increase of 25 pounds. In 1934 the x-ray examination showed the bile ducts filling only in the right side position. The patient, then 80 years of age, was reexamined in 1938; there were no complaints or fever from the bile duct; only the big ventral hernia troubled the patient occasionally.

Choledochoduodenostomy is relatively seldom performed for fear of ascending infection. It is regarded as indicated only when there is a complete obstruction of the common duct by cancer of the pancreas, if a cholecystduodenostomy cannot be performed. Mallett-Guy has collected from the literature 12 cures and 8 later deaths of ascending infection and has warned against this operation because of its 40 per cent mortality. From my own experiences I have contested this argument repeatedly and have showed that this lack of success does not occur with the typical side-to-side anastomosis, but only with the end-to-side anastomosis, because the latter tends to stenosis and thus permits the ascending infection because of imperfect drainage of the common duct. I could show that just those cases whose bile ducts fill on x-ray examination give excellent permanent results. The following is an example:

A 64-year-old man was operated upon in 1922 because of common duct obstruction, with fever and chills (for four weeks daily 39°; daily chills). The common duct and hepatic duct were very dilated and contained twenty stones and purulent bile. After cholecystectomy, a 2 cm. wide choledochoduodenostomy was performed. The patient up to now is wholly free from any complaint and has gained 55 pounds in weight. X-ray examination with barium per os shows a complete filling of the ramifications of the hepatic ducts; nevertheless, complete health has been maintained for eighteen years without any change.

TABLE V

END RESULTS

	COMMON DUCT DRAINAGE	CHOLEDOCHODUODENOSTOMY
Cured 3 to 17 yr.	5	42 = 93.3%
Improved	1	3 = 6.6%
Failure	7	0

The permanent results of the choledochoduodenostomy are very good. Among 48 cases operated upon, three to seventeen years ago, 2 cases died within 3 years from cancer of the pancreas with liver metastases; one 72-year-old patient, after complete good health, died from grippneumonia. Forty-two of the remaining 45 cases, or 93.3 per cent, were free from complaints for from three to seventeen years, gained their normal weight, and never had fever and spasms of jaundice.

With 24 cases the operation was performed eleven to seventeen years ago so that one may really speak of permanent cures. Two patients are sometimes afflicted with ulcer complaints which disappear again after medical treatment; one patient suffers from chronic colitis which existed before the operation. There is no uncured case nor any case of ascending infection.

The permanent results of the common duct drainage or suture of the common duct are not so good. Floercken had only 51 per cent permanent cures. Bernhard reports about 30 per cent from Popper's clinic. I have, among 13 cases of common duct drainage or suture of the common duct, 5 cases cured, 1 improved, 7 uncured, among which are 3 cases with persisting bile fistula.

Choledochoduodenostomy gives excellent results also with chronic pancreatitis. I used it on 10 patients, all of whom recovered. Seven cases are absolutely cured after three to twelve years; 2 cases were operated upon only four months ago; 1 case died from liver metastases after one year. Also, in cases of chronic pancreatitis, I prefer choledochoduodenostomy to cholecystostomy, cholecystectomy, or dilatation of the papilla, which is still frequently commended but which often leads to failure.

I have applied choledochoduodenostomy also in those patients who had further complaints referred clinically to gallstones left behind in the common duct after cholecystectomy. These stones were not discoverable at the operation, but instead a relative stenosis of the papilla partly by cicatrization, partly by swelling of the head of the pancreas was found. I performed the operation 10 times without any deaths; 8 cases are wholly free from complaints after a period of three to ten years; 2 cases operated upon only six months ago are not applicable for the evaluation of the permanent results. Among these, one patient is particularly interesting; he was operated upon ten years ago by Walzel because of stones in the common duct. At that time, apart from the cholecystectomy, the dilatation of the papilla was performed. One patient suffers sometimes from chronic colitis. One patient is uncured. He sometimes has severe pains and also jaundice. Here repeated x-ray examination shows that the bile duct does not fill; the anastomosis, therefore, has closed.

From my experience, I communicate the following rules for my treatment of common duct obstruction by stones:

1. In all cases the diseased gall bladder is removed.

2. If the common duct be occluded by a solitary stone and the papilla be permeable, the common duct is sutured after extraction of the stone and only the abdomen is drained.

3. If the papilla be stenosed and not dilatable, choledochoduodenostomy is applied.

4. If apart from the obturating stone there are additional stones but no infection, the common duct is sutured, provided I can be sure that all stones have been removed.

5. If in a case of common duct obstruction with fever of short duration purulent bile is found, the common duct is drained after removal of the stone, an anastomosis being difficult and dangerous because of the thin wall of the common duct.

6. If the trouble continues, the choledochoduodenostomy is performed at a second operation.

7. With multiple stones in the common duct, purulent cholangitis, relative stenosis of the papilla by cicatrices or chronic pancreatitis, a side-to-side anastomosis 2 cm. long is made between the common duct and the duodenum. In these cases the abdomen is always drained.

I know my series is too small to draw conclusions of general value. Nevertheless, I can recommend to my colleagues these conclusions and am convinced they will obtain with them the same good operative results and permanent success if they will eliminate wholly the deep ether narcosis at all operations and replace it by local anesthesia of the abdominal wall and splanchnic anesthesia or combined with nitrous oxide narcosis. Cholelithiasis is such a common disease that even slight improvement in the operative technique with the accompanying improvement in the final results makes a contribution to the welfare of man for which it is well worth striving.

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SOLITARY NONPARASITIC CYST OF THE LIVER

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UNUSUAL abdominal tumors are of interest because they so often defy clinical diagnosis. Davis'[1] extensive study of nonparasitic liver cysts revealed 187 reported cases of a solitary cyst to which he added one. This indicates a recently aroused interest in this condition as Stoesser and Wangensteen's[2] review only eight years previously placed the number of cases on record at 104. Although much has been written about the symptoms produced by these tumors, very few have been recognized clinically. Many have been mistaken for ovarian cysts, while hydrops of the gall bladder,[3] mesenteric cyst, and hydatid cyst have been other favorite preoperative diagnoses. Harrington, of the Mayo Clinic (in a personal communication to Jones),[4] states that three of their series of twenty-five cases were diagnosed as tumors or cysts of the liver. Despite the rapidly increasing number of such cases reported in recent years, it seems that the condition is still sufficiently rare to warrant placing on record another.

CASE REPORT.—Mrs. E. L., aged 20 years, entered the Evanston Hospital complaining of frequent pain and a sense of fullness in the abdomen. She had been conscious of a gradual increase in the size of her abdomen for about one year. Six months previously she had suffered a severe attack of abdominal pain which was confined chiefly to the lower abdomen. When examined at that time, tenderness was found most marked in the right lower quadrant and a diagnosis of acute appendicitis was made. The W.B.C. was 11,500. The symptoms subsided rather rapidly, however, and an expectant course was advised. She states that since this episode very few days had passed that she had not experienced some abdominal discomfort. She had noticed an increasing tendency to constipation and the act of defecation sometimes occasioned pain, particularly in the suprapubic region; she felt that there was some obstruction near the outlet which interfered with elimination. Dyspareunia was also mentioned. For the past few months her menses had been about a week late; there was no intermenstrual bleeding and no dysmenorrhea. Physical examination indicated a well-nourished but somewhat pallid young Italian girl whose abdomen exhibited a fullness which appeared abnormal. The abdomen was everywhere tender to palpation but most sensitive just above the pubis. Percussion indicated the presence of encapsulated fluid which was easily ballotable; the fundus of the tumor appeared to occupy the lower abdomen. Pelvic examination disclosed a tumor which seemed to lie above the tip of a freely movable, normal uterus and whose upper limit could be palpated just above the umbilicus. The W.B.C. was 10,700; R.B.C., 4,890,000; Hb., 13.5 gm.; and the urine was essentially negative. A diagnosis of ovarian cyst was made and surgery advised. A low midline incision was made and the peritoneum opened. A large bluish walled cyst was seen to occupy almost the entire abdominal cavity (Fig. 1). Exploration of the pelvis furnished proof that the tumor was independent of any of

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the pelvic organs. At its upper end the tumor was found to narrow down to a stalklike pedicle which appeared attached to the under surface of the liver. It was then decided to remove the body of the tumor and make a second incision over the gall-bladder area for further investigation of the pedicle. Accordingly, this plan was carried out, the cyst being sectioned between clamps as high as possible and the original incision quickly closed. A second incision was made obliquely from the xiphoid across the rectus muscle to a point approximately 2 cm. lateral to the umbilicus. The pedicle of the cyst was seen to arise high on the under surface of the right lobe of the liver (Fig. 1). This was carefully dissected free from the substance of the liver, clamping and ligating the large blood vessels contained in the wall of the pedicle as the dissection proceeded. The second incision was then closed in layers.

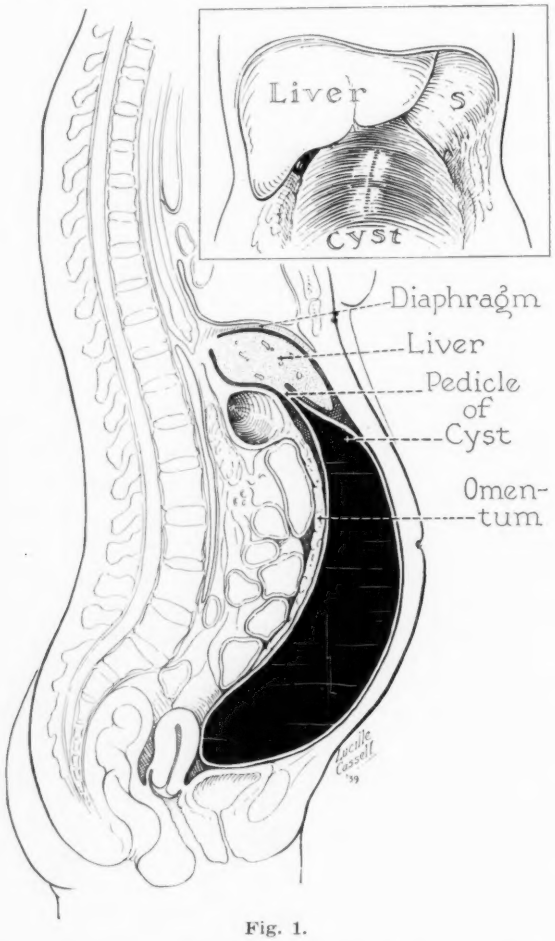

Fig. 1.

The patient made an uneventful recovery and was discharged from the hospita. on her eleventh postoperative day. When last seen, eight weeks later, she was in good health and no evidence of any recurrence was found.

A description of the tumor as given by Dr. E. L. Benjamin, pathologist at the Evanston Hospital, is as follows:

"*Gross Description:* This cyst, the size of a child's head, is filled with approximately 2,000 Ml. of thin, turbid, dark yellow fluid. Upon opening this cyst a bag

resembling an inner tube of a tire is removed. It is 1-2 mm. thick and composed of homogeneous, resilient, dull green, fibrinous cast with 1-3 mm. ochre yellow deposits. The wall of the cyst is 0.5-1 mm. thick. Its external surface is smooth and gray and numerous blood vessels course throughout the membrane. The internal surface is smooth, glistening, red, tinged with yellow.

"The second specimen received, which apparently corresponds to the pedicle, has a thicker, more fibrous wall than the cyst. Its inner surface is infiltrated with broad plaques of ochre yellow material. The circumference is approximately 6 cm.

"*Fluid:* Microscopic examination of the fluid reveals a moderate amorphous colorless precipitate, an occasional cholesterol crystal and leucocyte.

"Chemical examination reveals the following: reaction—alkaline; bile—present; cholesterol—present; mucin—faint trace; carbohydrates—negative. Protein—18 grams per liter.

"*Microscopic Description:* Sections taken from the cyst wall near its origin reveal a thick, hyalinized wall partly stained by yellow pigment. The internal surface in some areas is lined by a thin, flattened, nondescript layer of cells beneath which there is a thick erythrocytic extravasation about numerous small single endothelial-lined vascular channels and an occasional slightly thickened, hyalinized vein. In the wall there are also seen several cross sections and oblique sections of tubes lined by cuboidal epithelium resembling bile ducts. A heavy round cell infiltration with an occasional neutrophilic and eosinophilic polymorphonuclear leucocyte is also seen in the wall. Sections taken from the fundus of the cyst show a much thinner collagenous connective tissue wall in which are incorporated numerous small blood vessels. The external surface exhibits no distinct covering. The internal surface is lined by a multilayered narrow columnar epithelium. At the base of the mucosa there is occasionally seen a large macrophage containing yellow pigment. In places the cytoplasm of the macrophages is slightly foamy.

"Diagnosis: These findings are compatible with a diagnosis of a congenital cyst of the biliary system."

The etiology of these nonparasitic cysts arising from the liver has not been definitely established. Most plausible is the theory that they arise from aberrant bile ducts.[5] The discovery of several tubes cut in cross section and lined with cuboidal epithelium would suggest the probability of such a mode of origin in the present instance. Most investigators in this field are agreed that such cysts are congenital in nature. The majority of the pedunculated cysts appear to arise from the under surface of the liver, the right lobe being most commonly involved.

As was stated earlier in this report, very few cases of congenital biliary cysts have been diagnosed prior to operation. Symptoms may be entirely absent. When present, they are due either to pressure, torsion of the pedicle, or rupture of the cyst wall with escape of fluid into the peritoneal cavity. In trying to account for our patient's acute bout of abdominal pain six months previous to operation, it seems not unlikely that a small leak of the cystic fluid through the thin cyst wall may have been responsible. Again, it is entirely possible that this pain may have been independent of the hepatic cyst. The frequent discomfort experienced up until the time of her operation no doubt was due to pressure exerted by the cyst on such organs as the bladder, rectum, and uterus.

Practically all cases in which the tumor has been removed surgically have gone on to a satisfactory recovery. Apparently the incidence of recurrence is low. Even those cases in which marsupialization[2] has been carried out appear to have gotten well without return of the condition. Cotton and Burgess[6] report a recovery following drainage of the cyst. The mortality following surgery has been variously estimated at from 12 to 33 per cent.

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THE MAINTENANCE OF NUTRITION IN SURGICAL PATIENTS, WITH A DESCRIPTION OF THE OROJEJUNAL METHOD OF FEEDING

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THE nutrition of the surgical patient has become of increasing importance to the surgeon since it has been shown that a variety of complications following anesthesia and operation are the result of prolonged nutritional disturbances. The studies of Goldschmidt, Vars, and Ravdin[1] have demonstrated that the major conditioning factor in the production of necrosis of the liver following the use of volatile anesthetics is the amount of hepatic fat which is present at the time of anesthesia. These workers have found that an abundant supply of hepatic glycogen is efficacious in preventing necrosis of the liver only if the hepatic lipid concentration is reduced as the result of the glycogen deposition. Another factor of considerable importance in the prevention of hepatic injury is the presence of an adequate store of readily available protein. The liver with a high carbohydrate-protein store is maximally prepared for the insult by volatile or lipid solvent anesthetics.

Jones and Eaton[2] first called attention to the hazards of hypoproteinemia in surgical patients. The experimental and clinical studies of Mecray, Barden, and Ravdin[3] confirmed and extended their observations. Mecray and his associates demonstrated that gastric emptying time was greatly prolonged in hypoproteinemia, even in the intact stomach and even though there was no deficiency of any known accessory foodstuff.

Thompson, Ravdin, and Frank[4] found hypoproteinemia to be associated with a delay in fibroplasia in the dog and suggested that this condition might be a factor in wound disruption in surgical patients. Confirmation of this has now been obtained in several patients who have suffered abdominal wound disruption.

Not only is there frequently a deficiency in the primary foodstuffs, but many of the patients coming for operation also have a subclinical or clinical deficiency of certain of the vitamins. A deficiency in the B complex results in prolongation of the period of emptying of a water-barium meal from the stomach. The small intestinal pattern also is greatly disturbed in a B complex deficiency. Heublein, Thompson, and Scully[5]

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have shown that the administration of large amounts of thiamin hydrochloride (B_1) and riboflavine (B_2) does not restore the gastrointestinal activity and pattern to normal. This restoration to normal occurs only after the administration of the entire B complex.

Lanman and Ingalls[6] found that a vitamin C deficiency results in a marked delay in wound healing and their results have been confirmed by Taffel and Harvey.[14] Thus, two nutritional factors, hypoproteinemia and a vitamin C deficiency, are now known to be factors in wound disruption.

The use of vitamin K and bile salts in overcoming the prothrombin deficiency of patients with obstructive jaundice is another example of the importance of nutrition in surgical patients. That an absence of bile salts from the intestinal tract results in the failure of the absorption of vitamin K from the normal dietary has now been amply confirmed. Such a circumstance leads to a reduction of the prothrombin concentration with its resultant tendency to bleeding.

These complications of surgical patients, many of which were previously explained on a mechanical basis, have greatly increased the interest of the surgeons in the state of nutrition of patients who are to be subjected to operation. The frequency with which hypoproteinemia may cause and accentuate the edema around a newly formed gastroenteric anastomosis, so as to mimic in every way a technical defect of the anastomosis, led us to investigate the methods by which the hypoproteinemia might be overcome prior to and controlled subsequent to operation.

METHODS AND MATERIALS

Diet.—It is of primary importance that, where operation is not of an emergency character and where evidence of an existing nutritional deficit exists, an attempt should be made an improve the nutrition of the patient prior to operation. A high carbohydrate-protein dietary is the most satisfactory method of supplying the primary nutritional requirements of the surgical patient, without increasing the hazards of anesthesia and operation.

The oral method is not only the method of choice for the administration of carbohydrate, protein, and the necessary fat, but it is also a very satisfactory route for the administration of the accessory foodstuffs, the vitamins. In fact, certain of these have not been isolated in pure form and are thus not available for parenteral administration.

When the oral route is used, it is important to select a diet which contains foodstuffs which are readily assimilable and which can be given in sufficient amounts, not only to supply the calories for energy requirements, but in addition to replenish deficient carbohydrate and protein stores. The caloric requirements for such a program generally are in excess of those offered in the three-meals-a-day dietary of the average hospital. Even when offered, a record often is not kept of how

much the patient has actually eaten, so that the actual caloric intake is not known. A diet which contains 60 to 80 per cent of carbohydrate, 20 to 30 per cent of protein, and 5 to 10 per cent of fat in the total calories as a rule is satisfactory. We believe that the level of fat in the diet should be kept as low as possible.

During the period of oral feeding, the intravenous use of glucose is of value more for the effect it has in sparing protein stores than for any other reason. The total calories available from 3,000 c.c. of a 5 per cent glucose solution are 600, which is but one-third of the basal caloric requirements. When no contraindication to extensive oral feeding exists, the patient can readily receive adequate calories by mouth and the intravenous route is not required.

The Orojejunal Method.—As the result either of anorexia, which frequently can be corrected by the administration of brewers' yeast, or of obstruction, adequate oral feeding is often not possible. If the nutritional state of the patient is such that the major operation is extremely hazardous, it is at times wise to perform a jejunostomy to feed the patient. Where early operation is imperative, the plasma proteins may be maintained at a normal level by the use of blood, serum, or plasma. In a later paper we shall discuss the use of these materials.

It has been our experience that, even in patients with roentgen evidence of complete pyloric obstruction from ulcer or cancer, the drainage of the stomach for several days by the method of Wangensteen and Paine[7] frequently results in the disappearance of some of the edema associated with the obstruction so that a Levin or Abbott tube will pass into the jejunum. When this occurs, intensive orojejunal feeding can be begun.

Where feeding is carried out after a gastric resection or simple gastroenterostomy, the special Abbott gastrojejunal tube[8] is passed into the distal loop of jejunum before closure of the abdomen (Fig. 1). The Abbott tube permits of suction from the stomach through one lumen (*A*), and feeding into the jejunum through the other (*B*).

Either before or after operation, as the case may be, a feeding mixture can be administered through the tube. We introduce the mixture with an apparatus devised by Stengel and Vars (Fig. 2) which permits of automatic feeding, either continuous or intermittent. All that is required is to attach the flasks containing the feeding mixture to the feeder tube. An electrically driven modified DeBakey transfusion pump (*A*) is connected to the special Abbott tube placed in the patient's stomach just prior to operation and carried into the jejunum at operation. We have used three DeBakey tubes (*B*) connected together to secure the desired volume output. The sterile protein-glucose-salt mixture is stored in 1 L. flasks (*C*) and these are connected to the intake of the pump. In addition, a time device has been added to the pump used in our experimental studies. The essential principle of this is the periodic

activation of a microswitch by a cam revolving slowly (*E*) on the shaft of a small synchronous telechron motor (*D*) geared down to the ratio of 120:1. The microswitch controls the electric current to the pump's motor. According to the construction of the cam, it is possible to obtain varying periods of feeding with alternate intervals of rest. As a rule

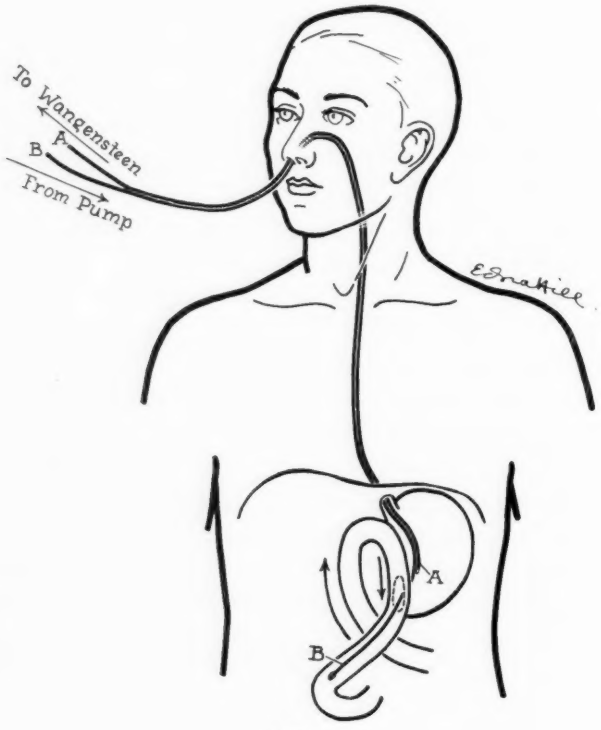

Fig. 1.

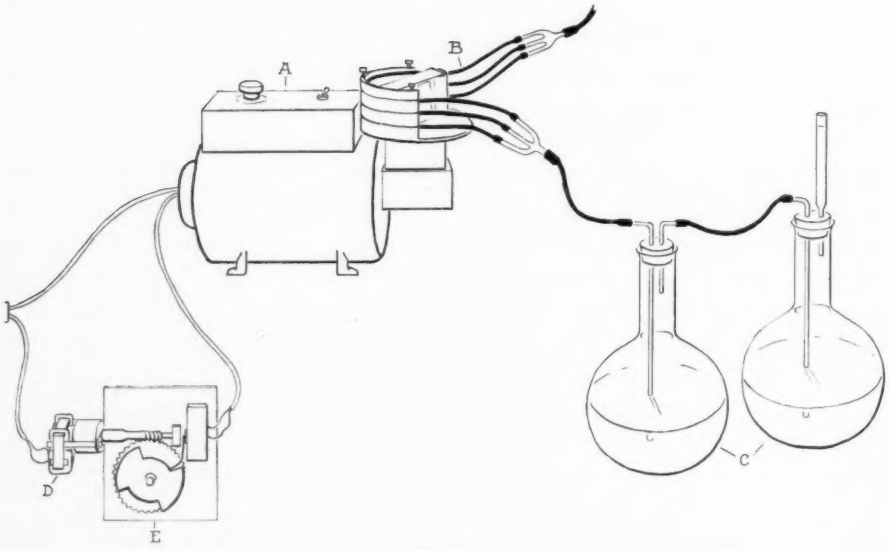

Fig. 2.

we have started the patient on a program of feeding for thirty minutes and an equal period of rest, but when peristaltic activity becomes normal it is possible to feed the patient forty-five minutes out of each hour, or even ninety consecutive minutes out of each two hours. The timing device greatly facilitates automatic periodic orojejunal feeding.

Since some of the patients before operation and many of them for a time subsequent to operation have some interference with enzyme production, the feeding mixture is partially digested so that it may be easily absorbed from the jejunum.

We are using a peptone hydrolysate first made for us by Dr. David Drabkin, of the Department of Physiological Chemistry of this medical school, and more recently supplied to us by Merck and Company. The ratio of amino nitrogen to total nitrogen of this latter preparation is 1:1.87. The partially hydrolyzed peptone is put in solution in boiling water and varying amounts of glucose are added, depending upon the concentration of protein and carbohydrate we desire in the final feeding mixture. In addition we daily add sufficient sodium chloride to maintain a normal plasma chloride concentration. With this method intravenous fluid and salt administration is not required and the patient can be supplied sufficient calories for energy requirements and for maintaining or replenishing a protein deficiency. In the patients in whom we have used this method, we have not pushed the caloric intake but the total calories administered in a twenty-four-hour period can be increased to 1,500 or more daily without the slightest difficulty. It is, of course, obvious that such a program is efficacious only when there is no lesion present which prevents the formation of serum proteins when the components are offered in the dietary.

Control Patient.—The following case history represents what we believe may be expected in patients subjected to gastric operations when no special attention is directed to their nutrition prior and subsequent to operation.

CASE 1.—J. McL., Surgical No. 41078, white male, aged 50 years, was admitted to the medical service of the Hospital of the University of Pennsylvania on Oct. 19, 1938. Some months previously he had been operated upon for a perforated duodenal ulcer. He was still having pain of the ulcer type. The serum protein was 6.5 gm. per cent on Nov. 1, 1938. Just prior to operation, he was given a transfusion of 400 c.c. of blood. Following a subtotal gastrectomy on Nov. 5, 1938, the stomach was kept empty by suction drainage, and fluids, saline and glucose, were given intravenously. The patient received a daily average of 628 calories by this method. On Nov. 12, 1938, the serum proteins were 4.3 gm. per cent.

This patient illustrates the fall in the serum protein concentration which may occur during the period of protein restriction and hydration which often follows operation.

Patients Receiving Orojejunal Feedings.—

CASE 2.—R. C., Surgical No. 40697, white male, aged 21 years, admitted to the medical service of the Hospital of the University of Pennsylvania on Oct. 1, 1938, with a diagnosis of penetrating duodenal ulcer. He was transferred to the surgical service on Nov. 7, 1938. The serum proteins on Nov. 9, 1938, were 7.3 gm. per cent and on the following day a subtotal gastrectomy was performed. The Abbott tube was placed into the distal jejunum after completion of the anastomosis. Following operation he was given a transfusion of 500 c.c. of blood, and saline solution and glucose were begun intravenously. His serum proteins fell to 6.1 gm. per cent. All parenteral fluids were stopped except for 1,500 c.c. given on the third day following operation, and feeding through the Abbott tube was begun on Nov. 11, 1938. He received, by this method, approximately 74 gm. of protein and 181 gm. of glucose daily. Thus, the patient received a daily average of 1,024 calories. In addition, sufficient sodium chloride was added to the feeding mixture to maintain a normal level of the plasma chlorides. On this nutritional program the serum proteins had risen to 6.7 gm. per cent on Nov. 15, which was the final day of special feeding.

CASE 3.—M. F., Surgical No. 40463, white male, aged 52 years, admitted to the surgical service of the Hospital of the University of Pennsylvania on Oct. 25, 1938, with the diagnosis of gastric carcinoma. After suction drainage of the stomach for a few days, a feeding tube passed the pylorus. At this time (Oct. 28) the serum proteins were 7.7 gm. per cent. Following restoration of the fluid and electrolyte balance, the serum protein fell to 6.6 gm. per cent. The feeding program was continued for twelve days before operation, the patient receiving 60 gm. of protein and 190 gm. of carbohydrate daily to which was added sufficient sodium chloride to maintain a normal plasma chloride concentration.

The jejunal feeding was continued for eight days postoperatively, during which time the protein intake was approximately 53 gm. and the carbohydrate 197 gm. daily. The serum protein concentration never fell below the preoperative level and was 6.9 gm. per cent at the conclusion of the feeding period. The patient thus received a daily average of about 1,000 calories, both prior to and following operation.

DISCUSSION

In any method where the oral or orojejunal route is utilized, it is important to determine, if possible, whether any condition exists where, even though all the components of tissue and serum protein are given, protein synthesis, both tissue and serum, may fail to occur. There is information to the effect that intestinal absorption may be definitely impeded in the presence of certain of the vitamin deficiencies. Calcium absorption from the intestine is retarded in the presence of a vitamin D deficiency and the fact that some hyperthyroid patients fail to gain, or even maintain, their weight, even though more than sufficient food is ingested to take care of the increased energy demands, suggests that certain of these patients may have interference with the intestinal absorbing mechanism.

Melnick and Cowgill[9] recently have reviewed the subject of hypoproteinemia and have shown how complicated the problem may be. These authors, while admitting that the "loss and lack" theory explains many of the problems of hypoproteinemia, find that it is not compre-

hensive enough to "explain the observed facts in all instances of hypoproteinemia." They agree with Peters and co-workers,[10] Bing,[11] and others that "some other factor, possibly injury to or an inhibition of the serum protein regenerating mechanism, must be postulated as an accessory agent."

It is a fortunate circumstance that in the type of patient discussed in this paper hypoproteinemia is essentially the result of failure of proper alimentation. It is as a rule amenable to correction through the addition of an adequate dietary. It is, however, important that the diet be satisfactory from the standpoint of its composition and also in the amount provided each day.

The average gastrostomy diet frequently will supply sufficient total calories, but generally contains considerable fat in order that the total calories be high and the bulk relatively small. The addition of much fat to the preoperative diet is, we believe, a mistake, for evidence which we have obtained in this laboratory demonstrates that with an abundance of fat in the diet the hepatic lipid concentration is increased to levels which predispose the liver to serious injury during anesthesia regardless of the presence of carbohydrate and protein in the feeding mixture.

Up to the present time we have restricted the orojejunal feeding mixture in the pre- and postoperative periods to carbohydrate, protein, sodium chloride, and certain accessory food substances. In the postoperative period fat could safely be added to increase the caloric value of the mixture. It must be remembered that following anesthetization, especially with the volatile anesthetics, bile salt production in the liver and, therefore, the amount of bile salt in the bile for a time is greatly reduced. There results, therefore, the danger that lipase activity and fat emulsification and absorption may be retarded during this period of depression of hepatic activity. Such a circumstance might result in a fatty diarrhea and lead to decreased absorption of the other components of the feeding mixture. This aspect of the problem requires further investigation.

The Abbott tube which we are now using is simple in its construction and does not depend upon the use of valves as described in the original Abbott-Rawson tube.[12] It required a few movements to pull it down into the jejunum following completion of the anastomosis. When it is used, gastric suction drainage and jejunal feeding take place simultaneously.

The feeding machine, while not necessary, is desirable. It provides for a uniform rate of feeding, with periods of rest if these are found to be desirable. It measures the amount of material which has been fed and this feature is of value in calculating the daily caloric intake. Above all, it does away with dependence on a nurse, intern, or

resident to fill the cannula holding the feeding mixture. The patient is fed whether he is awake or asleep with a minimum of discomfort and disturbance.

It is possible to use protein mixtures which have not been partially digested. We have used a partially digested protein because absorption is more readily obtained. Data which have been published recently by Rhoads, Stengel, Riegel, Cajori, and Frazier[13] demonstrate that more amino nitrogen is absorbed from the jejunum per unit of time from this hydrolysate than is absorbed from an amino acid mixture prepared by the acid hydrolysis of casein. This, they explained, was probably due to the fact that there were available in the peptone hydrolysate larger amounts of the more readily absorbable amino acids.

It has been our experience that the early introduction of the feeding mixture into the distal jejunum results in the earlier return of peristaltic activity after operation. We have been impressed by the smoothness of the convalescence and by the fact that the patients do not request food, even though orojejunal feeding, in some instances, has been continued for as long as fourteen days after operation and the caloric intake has not been high. During this period of time, fluid and electrolyte balance, as a rule, can be maintained without resort to intravenous administration. This is of some importance for it has been our experience that phlebitis frequently occurs where prolonged intravenous therapy, especially with glucose, is maintained. The injudicious intravenous use of large amounts of sodium chloride in the postoperative period frequently precipitates edema in a patient who would not have developed this complication had nutrition been maintained and had not the water and salt intake been excessive. Too much emphasis has been placed on the fluid and salt requirements of these patients and too little on associated factors which play an important part in keeping fluids in the blood vessels.

The method need not be used in all cases for not all patients have suffered prolonged nutritional deficits. It can be used, however, in every patient subjected to a gastroenteric anastomosis where suction drainage is to be carried out after operation, for in them it simplifies the postoperative management since the nutritional requirements of the patient can be more adequately fulfilled.

SUMMARY

1. Attention has been called to some of the dietary deficiencies occurring in surgical patients.

2. The orojejunal method of feeding has been described and the advantages of this type of feeding, when there is no interference with the protein regenerating mechanism, has been pointed out.

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RESULTS OF INTRAVENOUS AND INTRA-ARTERIAL ADMINISTRATION OF FLUIDS IN TRAUMATIC SHOCK PRODUCED EXPERIMENTALLY

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IN REVIEWING the literature on shock, one is struck by the large number of methods outlined for the treatment of this condition. This fact tends to reflect, in some measure, the many hypotheses and ideas that have arisen concerning the cause of shock. As each new hypothesis has developed, the treatment has been changed in order to combat the newly suggested cause. Owing to the work of many investigators, it is a well-recognized fact that in secondary shock there is a decrease in circulating blood volume. For this reason the replacement of the lost fluid by blood or other suitable solutions has been suggested by many authors as the logical treatment of shock. The usual method of administration has been by injection into one of the superficial veins.

In the literature on shock and related subjects little work has been reported on the injection of fluids intra-arterially in these conditions. In a paper on experimental shock Davis[1] has shown that the injection of 25 per cent solution of sodium chloride intra-arterially and intravenously will produce effects that are entirely different. In the former instance the blood pressure is elevated and in the latter it is lowered. This work has been confirmed in a previous report by Kendrick and Wakim.[2]

In secondary shock one is dealing, not only with a decreased circulatory volume, but also with a decreased cardiac output. As a result of the work of Davis on intra-arterial injection of fluid, the question arose whether the intra-arterial injection of other solutions would elevate the blood pressure and increase the cardiac output of animals in a state of shock more effectively than the same solutions given intravenously.

Two series of experiments have been done to compare the relative value of administering fluids intravenously and intra-arterially in dogs in a state of shock produced experimentally.

METHODS

Animals weighing about 10 kg. were used in these experiments. Shock was produced by exposure and manual manipulation of the jejunum and ileum. A midline incision was made and the small intestine, from the ligament of Treitz to the ileocecal junction, was brought outside the peritoneal cavity. The same procedure was followed in each experiment and the intestine was manipulated for an equal length of time.

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The criteria used for estimating the degree of shock of the animals were hemoconcentration measurements and blood pressure readings. The concentration of the blood was determined on a Sheard-Sanford hemoglobinometer. Blood pressure taken from the femoral artery was recorded continuously through a mercury manometer on a revolving kymograph. Five per cent solution of *d*-glucose in saline solution, in quantities of 100 c.c. per kilogram of body weight, was used as the transfusion solution.

In the first series, consisting of twelve experiments, ether anesthesia was used. Anesthesia was induced in an ether chamber and maintained by autoinhalation. Only small amounts of ether were required to keep the animal anesthetized after shock had developed. The experiments were divided into two groups and, after the onset of shock, the fluid was injected intravenously in one group and intra-arterially in the other. When the intravenous route was used, the fluid was forced into the femoral vein by the gravity method at the rate of 15 c.c. per minute. When fluid was administered intra-arterially, it was injected into the femoral artery by a Woodyatt pump at a constant rate of 15 c.c. per minute.

In the second series, which consisted of four experiments, nembutal (pentobarbital sodium), 25 mg. per kilogram of body weight, was used intravenously as the anesthetic agent. When shock had developed, two of this series were given fluid intravenously and two intra-arterially.

In all the experiments hemoglobin determinations were made before and immediately after the anesthesia was started and at intervals of one hour thereafter until the subject was considered to be in a state of shock. Shock was considered to be present when the blood concentration had increased about 30 per cent. The percentage increase was based on the first specimen of blood taken in each experiment. This reading was considered normal for each subject and was arbitrarily called 100 per cent. Thus, when the hemoglobin had increased to approximately 130 per cent, the animal was considered to be in a state of shock. When the blood had reached this concentration, the blood pressure level was consistently between 75 and 85.

In order to compare the relative value of the methods of injection employed, it was necessary in all experiments to note the period required for shock to develop, the time required for the fluid to be given, and the survival time after the fluid was injected (Fig. 1).

RESULTS

In the first series of experiments, in which ether anesthesia was used, when 5 per cent solution of *d*-glucose in saline solution was injected intra-arterially, the average survival time was 2 hours and 18 minutes. When the same solution was injected intravenously, the average survival

time was 3 hours and 39 minutes. The survival time of the subjects in the second series, anesthetized with nembutal, following the intra-arterial administration of 5 per cent solution of *d*-glucose in saline solution, was 3 hours and 7 minutes; when the solution was given intravenously, the survival time was 10 hours and 30 minutes.

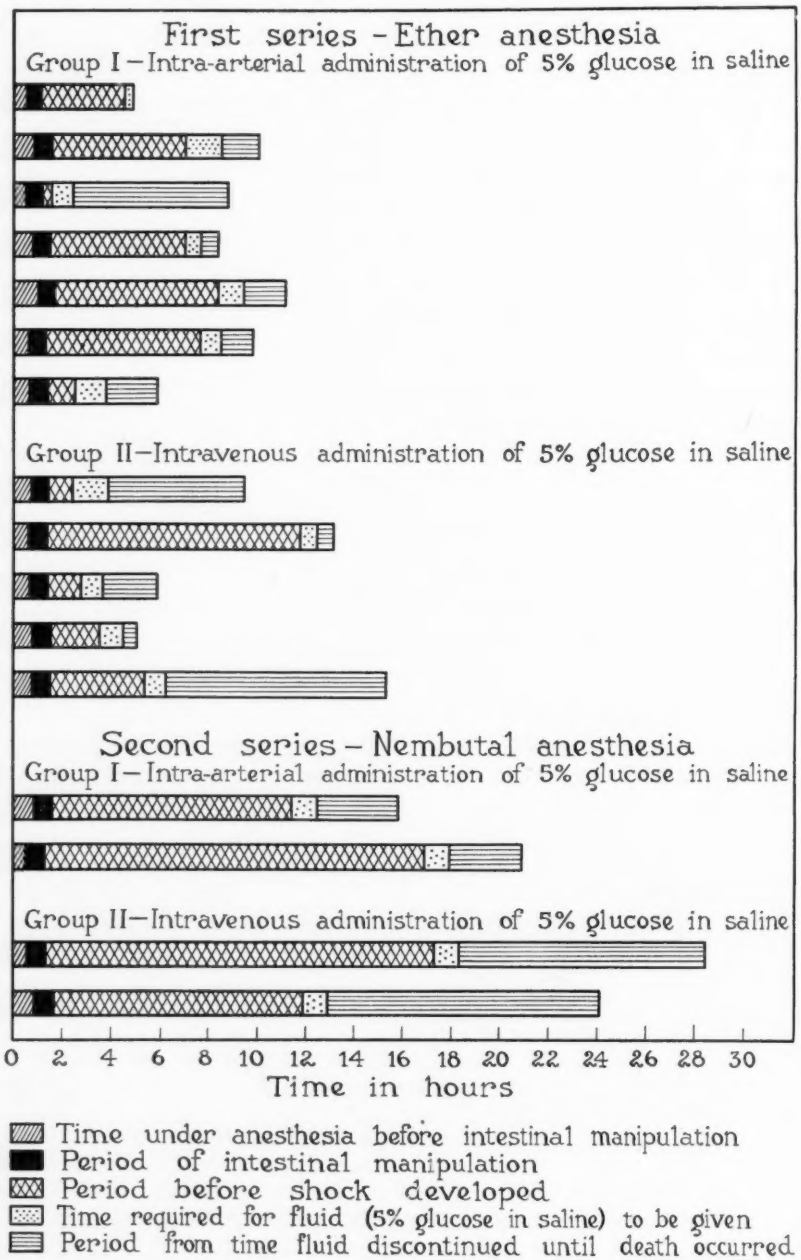
First series - Ether anesthesia
Group I - Intra-arterial administration of 5% glucose in saline
Group II - Intravenous administration of 5% glucose in saline
Second series - Nembutal anesthesia
Group I - Intra-arterial administration of 5% glucose in saline
Group II - Intravenous administration of 5% glucose in saline
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Time in hours
Time under anesthesia before intestinal manipulation
Period of intestinal manipulation
Period before shock developed
Time required for fluid (5% glucose in saline) to be given
Period from time fluid discontinued until death occurred

Fig. 1.—Graphic representation of the data on each series of experiments, showing the effect of administering fluids intra-arterially and intravenously in shock produced experimentally.

A comparison of the effects of the methods of anesthesia used on the rapidity with which shock developed reveals the following results. In the series in which the subjects were anesthetized with ether, the average time required for shock to develop was 3 hours and 52 minutes. In the second series, in which nembutal anesthesia was used, the average time required for shock to develop was 12 hours and 51 minutes.

COMMENT

It is interesting to observe the delay in onset of shock in dogs that have received nembutal anesthesia in comparison with those that have been anesthetized with ether. Moon[3] has emphasized that the barbiturates, when used as the anesthetic, hasten the onset of shock. However, shock was produced by a different method than the one used in my experiments. He further points out that a dog anesthetized with ether will withstand much more trauma without developing shock than animals narcotized with one of the barbiturates. Seeley, Essex, and Mann,[4] working on experimental shock, have shown that when sodium amytal is used intravenously as the anesthetic, in doses of 50 mg. per kilogram of body weight, the onset of shock is delayed an average of 7 hours longer than in similar experiments done with ether anesthesia. In my experiments the observations of Seeley, Essex, and Mann have been corroborated.

SUMMARY

A comparison has been made of the relative value of injecting 5 per cent solution of *d*-glucose in saline solution intra-arterially and intravenously in dogs in experimental shock. The results show that the intravenous route is preferable.

In the two series of experiments done, it has been shown that shock develops rather rapidly, following trauma to the intestines, when ether is used. When nembutal (pentobarbital sodium) anesthesia is used, the onset of shock is delayed several hours.

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ACUTE PERFORATED PEPTIC ULCERS

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THIS review comprises 152 cases of acute perforated peptic ulcers treated on the surgical services of the St. Louis City Hospital between July, 1932, and July, 1938. An analysis of the interesting features in the diagnosis, treatments, and results will be presented and a comparison made with other reports. All cases were on free beds and confined therefore almost exclusively to laborers and the less fortunately situated members of society, such as those on relief or the unemployed. Various nationalities were represented, but the majority were classified as Americans and all were white. In each case the diagnosis was confirmed either by operation or by post-mortem examination.

Incidence.—During the period selected for this study, there were 124,317 general admissions to the hospital, among which were 152 cases of perforated peptic ulcer, an incidence of 0.0012 per cent.

As is generally true, most of the perforations occurred in the middle years of life. There were 17.1 per cent of the patients under 30 years of age; 48.7 per cent between 30 and 50 years of age; and 34.8 per cent were over 50 years. The youngest patient was 19 years of age, and the oldest was 84 years, while the average age was 43.5 years. In Fig. 1, it can be seen that the mortality increases steadily with the age of the patient. All cases 70 years of age or over succumbed. Montgomery[1] reported an instance of a perforated ulcer in a man 75 years of age, who was operated upon and had an uneventful convalescence and subsequent good health.

Seasonal.—Much emphasis has been placed upon the seasonal occurrence of chronic gastric and duodenal ulcer symptoms. The symptoms have been thought to increase during the spring and fall months. Also, perforations have been stated to occur more frequently during these seasons. Hinton[2] found the frequency of perforations greater during the spring and fall months. In this series, however, the number of

TABLE I

SEASONAL VARIATION

	NUMBER	PER CENT
Fall	39	25.7
Winter	37	24.3
Spring	42	27.6
Summer	35	23.0

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cases occurring during the four seasons is approximately the same, there being only a slight increase during the spring and fall months (Table I). Since this increase is not enough to be significant, it can be concluded that in this locality the perforations are fairly evenly distributed throughout the year.

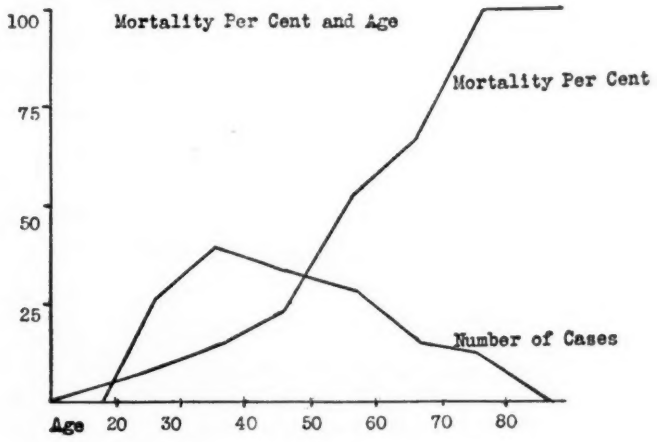

Fig. 1.

There has been little annual variation in the number of cases occurring during this six-year period (Table II). The average number of perforations yearly is 25.3. The number of deaths occurring yearly during this period varied greatly, but this depended upon so many factors that no one reason could be ascribed.

TABLE II

YEAR	NUMBER	DIED
1932	10	2
1933	25	10
1934	26	9
1935	27	8
1936	28	11
1937	25	5
1938	11	6

Sex.—There were but 7 females, representing 4.6 per cent of the cases of this series, while there were 145 males, or 95.4 per cent. This ratio of males to females compares favorably with many other reports, notably those of Urrutia,[3] Dineen,[4] Brown,[5] Mattingly,[6] and Sallick,[7] indicating that men are much more prone to have perforated ulcers than women.

SYMPTOMATOLOGY

Previous History.—One hundred and twenty-eight, or 84.2 per cent, of the patients gave a history of previous gastric disturbance as indicated by the preoperative histories. The fact that 84.2 per cent of the patients, while undergoing the agony of perforation, gave this informa-

tion indicates that it is a valuable aid in diagnosis. All gradations were noted from typical ulcer histories with patients under active medical treatment to cases which gave vague gastric complaints. The duration of symptoms varied from 7 days to 55 years. Sixty-one, or 40.1 per cent, stated that they had been treated for previous gastric disturbance. There were 24, or 15.8 per cent, of the patients who experienced the pain of perforation as the initiation of their gastric disturbance. No relationship was found between the duration of ulcer symptoms before perforation and the mortality rate (Table III). It is of interest to note that there were two cases which had undergone surgical closure of a previous perforation. Pearse[8] has reviewed the literature on recurrent perforations, examining the reports of 4,183 cases of perforated peptic ulcer, and found 33 instances of reperforation, an average of 1 in every 145 cases of perforation.

TABLE III

HISTORY OF PREVIOUS TREATMENT

DURATION	1-7 DAYS	7-30 DAYS	1-6 MO.	6-12 MO.	1-3 YR.	4-6 YR.	7-10 YR.	10 YR. OR OVER	SEV-ERAL YR.	NO DISTURB-ANCE
Number	7	22	11	6	19	17	10	20	16	24
Per cent	4.5	14.4	7.3	3.9	12.4	11.1	6.5	13.1	10.5	15.7
Died	1	5	5	1	7	4	4	9	5	10
Mortality (per cent)	14.5	22.7	45.4	16.6	36.8	23.5	40	45	31.2	41.6
Previous treatment	0	3	6	0	13	9	6	14	9	0

History of Perforation.—In ascertaining the history of the perforation, the various symptoms were evaluated to show the relative occurrence of each. These have been listed as gastric and duodenal because of the belief that chronic gastric and duodenal ulcers give typical histories. Due to the difficulty sometimes encountered in localizing lesions around the pylorus at the time of operation because of the edema and induration present, all ulcers classified as pyloric are considered in the duodenal group, and for the same reason it is justifiable to think that the symptoms are the same.

When the patient first experienced the pain of perforation, it was described as being in the epigastrium and general abdomen in 62 cases, or 40.7 per cent. The next most frequent location of the pain was in the epigastrium alone, which 52 cases, or 34.2 per cent, described. In 23 cases, or 15.1 per cent, generalized abdominal pain was described. This pain follows the escape of gastric and duodenal fluids into the free peritoneal cavity, and its extent is partly dependent upon the degree to which the peritoneal cavity is contaminated. Nevertheless, 74.9 per cent of the cases had pain in the epigastrium, indicating that it is a valuable symptom of a perforated ulcer.

In 132, or 87.4 per cent, of the cases the patient experienced a pain which was of the violently severe, knifelike type, causing the patient to "double up." The experience of this pain always remains fresh in the memory of the patient and is characteristic of a perforated ulcer. Only 11, or 7.2 per cent, of the cases had a pain described as dull; 5.4 per cent of the cases had intermittent knifelike pain; 16, or 10.5 per cent, of these latter cases had a slow onset.

Fifty-four cases were recorded as having referred pain on admission, but it is likely that many cases were not questioned about this. In Bryce's[9] report, in which the patients were questioned specifically, a higher percentage of cases having referred pain was encountered. In one-third of our cases the pain was referred to the right shoulder and 10, or 18.8 per cent, had pain in the left shoulder. There were 9, or 16.6 per cent, who had pain in both shoulders.

Vomiting after the perforation and before operation occurred in 113, or 74.3 per cent, of the cases; while 39, or 25.6 per cent, had no vomiting. This is an unusually high percentage as compared with the reports of Eliason and Ebeling,[10] Robitshek,[11] and Mattingly.[6] In only 7, or 6.1 per cent, of the cases was there blood in the vomitus.

In Table IV the symptoms of perforated gastric and duodenal ulcers have been listed, and indicate that an anatomic location of the ulcer cannot be made from the history of the perforation. This shows that no time should be wasted in deciding the location of the ulcer in relation

TABLE IV

HISTORY OF PERFORATION

PAIN ANNOUNCING PERFORATION	BOTH		DUODENAL		GASTRIC	
	NO.	%	NO.	%	NO.	%
General abdomen and epigastrium	62	40.7	56	40.3	6	46.6
Epigastrium	52	34.2	48	34.5	4	30.7
General abdomen	23	15.1	21	15.8	2	15.3
Mid- and lower abdomen and right upper quadrant	15	10	14	10	1	7.6
Referred pain						
Right shoulder	18	33.3	16	32.6	2	40
Both shoulders	10	18.5	8	16.6	2	40
Left shoulder	9	16.6	9	18.3	0	0
Back	4	7.4	4	8.0	0	0
Lower abdomen	13	24	12	24.5	1	20
Character of pain						
Knifelike	133	87.5	122	87.7	11	84.6
Dull	11	7.2	11	7.9	0	0
Intermittent	8	5.3	6	4.3	2	15.3
Vomiting with perforation						
Vomited	113	74.3	104	74.7	9	69.2
No vomiting	39	25.7	35	25.3	4	30.8
Vomited blood	7	4.6	4	2.8	3	23

to the pylorus, but emphasis should be concentrated upon establishing the diagnosis of the perforation.

Physical Findings.—Practically all of the patients on admission appeared to be in acute distress and suffering. Three of the patients were moribund at the time they were first seen and died soon afterwards. The great variability of the abdominal signs on admission can be explained on the basis of the time intervals allowed to elapse after the perforation. In 14 cases generalized abdominal tenderness and rigidity were present. In 117 cases there was generalized abdominal tenderness and rigidity in which the area of maximum localization was stated. In 76 of these 117 cases the tenderness was most marked in the epigastrium, 23 cases in the right upper quadrant, 9 cases in the right lower quadrant, and 9 cases in the left upper quadrant. In 13 cases tenderness was confined to the epigastrium and in 4 cases to the right upper quadrant. Twelve cases were recorded as having fluid in the flanks. Obliteration of hepatic dullness was noted in only 7 cases. In 1 case there were no localizing signs.

TABLE V

PHYSICAL SIGNS

	BOTH		DUODENAL		GASTRIC	
	NO.	%	NO.	%	NO.	%
General tenderness and rigidity	14	9.2	12	8.8	2	16.6
General tenderness and rigidity with tenderness most marked in:	117	76.9	107	78.6	10	83.3
Epigastrium	76	51.2	69	50.7	7	58.3
Right upper quadrant	23	15.4	21	15.4	2	16.6
Right lower quadrant	9	6.0	9	6.5	0	0
Left upper quadrant	9	6.0	8	5.8	1	8.3
Tenderness in epigastrium	13	8.5	13	9.5	0	0
Tenderness in right upper quadrant	4	2.6	4	2.9	0	0

In the usual description of a perforation, the patient is said to be in a state of shock immediately after the catastrophe occurs. This condition is not true shock. Although the temperature may be subnormal, the pulse will not be fast (usually below 100) and the blood pressure will be within normal limits. After this comes the stage of reaction in which the intensity of the pain subsides and the temperature and pulse are normal. This is then followed by peritonitis. Thus, the clinical findings at the time of admission showed marked variation, depending upon the stage of the illness and the physical condition of the patient.

In 149 cases in which the temperature was recorded on admission, it was found that 79.4 per cent had a temperature between 97 and 100°. The lowest temperature recorded was 96° and the highest 102.4°, while the average was 98.8°. The average pulse rate was 96 per minute, the minimum being 60 and the maximum 160. The average respiratory rate was 22 per minute, while 18 was the minimum and 38 the maximum.

Laboratory Findings.—In 146 cases the leucocyte count was taken. The average was 14,067; the lowest count was 3,000 and the highest 38,000. There were 5 patients with a leucocyte count below 5,000 and all of these died. Only 4 cases had a count over 30,000 and 1 of these died.

Roentgenography has been used as an adjuvant in establishing the diagnosis of a perforated peptic ulcer by the demonstration of a pneumoperitoneum. Vaughan and Singer[12] in 1929 reported this as a means of definitely establishing the diagnosis and reported 72 cases in which a pneumoperitoneum was demonstrated in 63. In this series 132 cases had films taken in the sitting-up position and a pneumoperitoneum was demonstrated in 91, or 68.9 per cent, while 41, or 31.1 per cent, had no air under the diaphragm. This procedure is very valuable in cases in which the diagnosis is doubtful and to rule out important nonoperative and medical lesions; nevertheless, the absence of a pneumoperitoneum should not be conclusive that a perforated ulcer is not present. In one instance an ulcer perforated while the patient was receiving a gastrointestinal x-ray examination, and the diagnosis was made immediately.

Preoperative Diagnosis.—Table VI lists the preoperative diagnoses as made in the admitting room or soon after entry to the hospital. In 83.5 per cent of the cases a correct diagnosis was made. In considering the diagnoses, 94.7 per cent were recognized as acute surgical emergencies requiring immediate operation. Acute appendicitis was the most frequent mistaken diagnosis and acute cholecystitis next. Acute pancreatitis and intestinal obstruction were other mistaken diagnoses.

TABLE VI

Perforated peptic ulcer	127
Perforated viscus, type undetermined	6
Acute appendicitis	4
Acute cholecystitis, intestinal obstruction, etc.	15

Mortality in Relation to Time of Perforation.—The length of time that elapsed between the onset of the attack and the operation varied greatly. It is universally recognized that an acute perforation constitutes a surgical emergency and delay in operation increases the mortality rate. In this series 140 cases were operated upon and Fig. 2 shows the time from the onset of perforation until the patient was operated upon. It is seen that the mortality increases steadily with delay in operation. An exception to this is the slight fall in death rate in those patients in which a delay of from forty-eight to seventy-two hours had occurred.

In these few cases there was a tendency to walling-off of the perforation and, although operated upon late, there was less peritoneal involvement and the patient's physical condition was better. In 106 cases operated upon within the first twelve hours, the mortality rate was 19.8 per cent.

Location of Perforations.—The large majority of perforations occurred in the anterior surface of the stomach and duodenum within 1 inch to 1½ inches of the pyloric vein. They were, for the most part, the characteristic type, being round, single, resembling a punched-out hole or opening, with the base of the ulcer being very indurated. The size of the perforations varied from 1 to 20 mm., the average being 5.5 mm. There was no correlation between the size of the perforation and the duration between perforation and operation. The majority of the larger perforations were found to be in patients who gave histories of ulcer symptoms of long standing. In 77 cases the perforations were in the duodenum and in 62 cases in the prepyloric area. The perforations described as prepyloric constitute those that are immediately proximal to the pyloric vein. Only 13 gastric perforations were found away from the pylorus. Three of these ulcers were at the cardiac end and 2 on the posterior surface of the stomach. In these cases the histories and physical findings were no different from the cases of duodenal perforations. There were 2 cases in which the ulcers were proved to be malignant. The mortality for duodenal ulcers was 31.6 per cent and for gastric ulcers, 53.8 per cent.

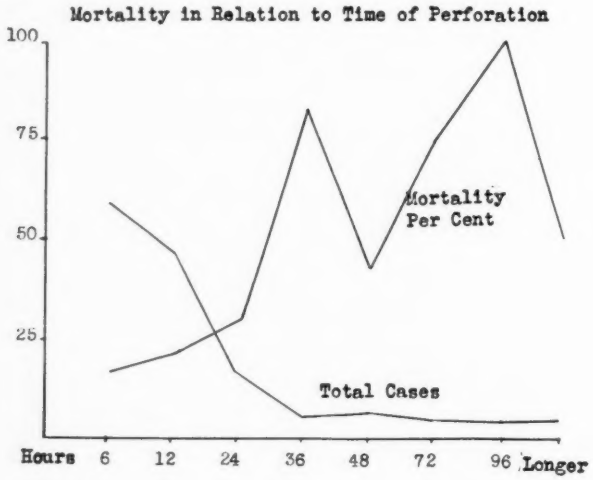

Fig. 2.

Treatment.—It is our belief that the simplest and quickest operation should be performed in acute perforations, and the operation of choice is simple closure by a purse-string and in a great many cases a tab of omentum was sutured over the closure. This procedure is used with the view in mind of preserving the life of the patient and seems to be fraught with the least mortality. The operations of gastroenterostomy, pyloroplasty, and gastric resection were performed infrequently or were reserved for a later date when conditions were more favorable. Later it will be shown that only a small percentage of cases

necessitated secondary operations, thus justifying the procedure. The majority of operations were performed by the resident surgeon, who changes yearly, so that a number of surgeons did the 140 operations. One hundred and twenty-four, or 81.5 per cent, had a simple closure of the perforation and only 3 patients had a simple closure with a gastroenterostomy. The percentage of mortality for simple closure was 25.8 and for pyloroplasty 25. The other types of operation had a much higher death rate. Pyloroplasty was reserved for ulcers in which there was a tendency toward walling-off and thus performed under more favorable circumstances than simple closure. Table VII shows the types of operations performed.

TABLE VII

TYPES OF OPERATION

	NO.	%	DIED	%
Simple closure	124	81.5	30	25.8
Pyloroplasty	4	2.8	1	25
Closure and posterior gastroenterostomy	3	1.9	2	66.6
Simple closure and appendectomy	2	1.3	0	0
Multiple drains only	2	1.3	2	100
Other procedures	5	3.4	4	80

Whether or not to drain the abdominal cavity has always been a subject of contention. Of 140 operated cases, 102 were drained, while 38 were not, and the mortality rate was practically the same in each group. Drainage was generally used where the perforation was of long duration or where the leakage excessive. A stab wound in the right flank was the choice site of drainage.

TABLE VIII

	NUMBER	DIED	PER CENT
With drainage	102	28	27.4
Without drainage	38	11	28.9

Spinal anesthesia (novocain crystals) was the anesthetic of choice. In 101 cases a spinal anesthetic was given and in 20 of these supplementary gas-ether was used. Thirty-one cases were given a general anesthetic. Local anesthesia was used in 8 cases in which the patients were considered poor operative risks. No deaths were due to the anesthetic.

If one excludes peritonitis, since all cases of perforation have a soiled peritoneum, pulmonary disease constitutes the largest group of complications. There were 24 pulmonary complications with a mortality rate of 37.5 per cent. Pneumonia, including lobar pneumonia and bronchopneumonia, constitutes 54 per cent of the pulmonary complications. There were 4 cases of atelectasis and 3 cases of pulmonary edema. The other complications include lung abscess, hydrothorax, and laryngeal edema. Fifty, or 37 per cent, had wound infections. A

wound was considered infected if the skin edges were separated and pus was present. This would probably indicate that more of the drains should have been brought out through stab wounds in the flanks or the wounds should have been drained down to the peritoneum. In 6 cases the wounds disrupted. Other complications include duodenal fistula and subphrenic abscess, with 4 cases each. Four patients had delirium tremens, 1 of whom died. Only 1 case developed a parotitis and only 1 case had a pelvic abscess as a complication.

Drainage of the stomach by use of nasal tube was used postoperatively in 76 cases, or 54.3 per cent, for an average of 4.3 days. It was used with increasing frequency during the last three years.

Results.—The mortality rate for the 140 operated cases was 39, or 27.8 per cent. There were 12 patients not operated upon and a post-mortem examination was made on all of these cases. In considering the nonoperated cases, there were 3 over 71 years of age who were in a moribund state upon entry and who died soon afterwards. Four cases were in extremely poor physical condition on entry and supportive measures were instituted, but the patients did not rally enough to consider operating. In one patient who died shortly after admission, the diagnosis was not made until post-mortem examination. There were 4 cases in which an incorrect diagnosis was made.

The average stay in the hospital for the patients who recovered was 25.1 days. The minimum number of days was 11 and the maximum 130 days. Fifty-one per cent of the postoperative deaths occurred within the first three days.

A follow-up was made on 57, or 56.4 per cent, of the 101 patients discharged. A patient was considered as having a good result if he had been entirely free from pain and had been able to work. A few of these patients remain on a diet. If the patient at times had pain which was easily controlled by a diet, it was considered a fair result. The patients who continued to have ulcer symptoms all the time were considered a poor result. By these standards, 43, or 75.4 per cent, were considered as having a good result; 10 cases, or 17.5 per cent, a fair result; and 4 cases, or 7 per cent, a poor result. According to Bryce,[9] any return in symptoms after a simple closure will take place within two years. He found in 48 patients in whom recurrence of symptoms took place and who stated the period of respite that in only 4 cases was it longer than one year and nine months. Table IX shows the length of time that our patients have been observed after the perforation. All patients with a fair or poor result with two exceptions had ulcer histories of long-standing duration, the average duration of symptoms being 6.5 years. Several of these patients were given a barium meal, most of them showing a constant nontender deformity of the duodenal bulb which may have been the result of surgery. One patient had a severe gastric hemorrhage several months

after operation but is now on a diet and in good health. One patient had a subsequent gastroenterostomy with good results and another had a partial gastrectomy and died during the postoperative period.

TABLE IX

YEAR	1932	1933	1934	1935	1936	1937	1938	TOTAL	%
Good	0	7	3	8	10	12	3	43	75.4
Fair	1	2	1	2	2	1	1	10	17.5
Poor	0	0	1	1	1	1	0	4	7.0

COMMENTS

Men are more prone to have perforated ulcers than women, but no satisfactory explanation for this can be made.

Perforations occur more frequently during the middle years of life and the mortality increases with the age of the patient. All cases 70 years of age or over died.

In this locality there is practically no seasonal variation in the number of perforations. The number of cases occurring each year is practically the same.

The majority of perforations have antecedent histories of gastric disturbance and the physical findings are fairly constant, thus enabling an early diagnosis. Roentgenography is an aid in establishing the diagnosis in doubtful cases. It has been shown that most cases can be diagnosed early and thus surgical intervention hastened.

The operative procedure employed is primarily directed at closing the source of contamination. In this series a simple closure was used with good results. Other men, notably Deaver,[13] Alexander,[14] and Mills,[15] use gastroenterostomy along with simple closure in early cases, but the results are not entirely satisfactory, since some of the patients were not entirely relieved of the symptoms. Pyloroplasty has been advocated by some men with varying results. Hinton[2] stated in his report that the results did not seem to justify the procedure. Gastric resection is the generally accepted procedure in Europe as emphasized by Graves[16] in his analysis of 4,402 cases from their clinics. In Europe multiple gastric and duodenal ulcers occur in an average of 30 per cent of the patients operated upon for acute perforations and, if the so-called ulcer-bearing area is not removed, there is a fairly high percentage of recurrence of symptoms due to the presence of remaining ulcers. This has not been our experience. The procedures other than simple closure are used to cure the ulcer and such operations performed under more favorable circumstances carry a mortality in themselves. Loehr[17] states that in 90 per cent of perforations of the duodenum and in 82 per cent of perforations of the stomach, the gastric contents are sterile and the number of organisms in any particular instance is controlled by the acidity of the gastric juice. Thus, one

can never be sure that the peritoneum is not contaminated in even an early case. Moreover, with only 7 per cent having poor results, it seems reasonable to delay additional operative procedures until a later date, when they can be performed when indicated.

The follow-up study gave conclusion that simple closure is an effective method of treatment. The persistence of ulcer symptoms after surgical closure of a perforation may be due to the existence of more than one ulcer, one of which perforated and was repaired surgically and the other left untouched. A chronic ulcer on the posterior surface of the stomach or duodenum easily could be overlooked if a perforated ulcer is present on the anterior surface. This fact is substantiated by two of our cases operated upon, each of which was found to have two ulcers, only one having perforated. Another case had two ulcers perforate simultaneously. The cases that have persistence of ulcer symptoms after a simple closure in which a reasonable period has elapsed after the institution of the proper dietary regime should have some type of radical surgery which is primarily directed at a cure.

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EXPERIMENTAL OSTEOMYELITIS: THE EFFECTS ON RIBS OF INCREASED INTRAMEDULLARY PRESSURE AND OF TOXIN- AND NONTOXIN-PRODUCING STRAINS OF STAPHYLOCOCCI

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AN INTERESTING method for producing an increase in the intramedullary pressure in long bones was described recently by Larsen.[1] This consisted, in brief, of making an incision in the periosteum of the femur and of perforating the cortex with a drill. A flanged cannula was then screwed into this opening and the cannula was connected to a Kelly bottle which contained sterile salt solution. In this manner pressures of any desired degree could be transmitted to the medullary cavity. The main disadvantage of this method of study would appear to be that evidences of infection appeared in most of the experiments. Another possible disadvantage lies in the necessity for making a rather large opening by a drill hole in the bone.

It occurred to us that these features might be obviated and that the effects of pressure and of infection might be separated by substituting for the cannula a needle which was introduced into the medullary cavity of bone through an adjacent cartilage. In this manner neither the periosteum nor the cortex of the bone would be injured and the chances of infection would be lessened. For these purposes, it seemed that the anterior portions of the ribs with the attached cartilages would be of advantage in that the ribs are very superficial and their multiplicity would allow a number of studies on the same animal. For example, the effects of increased intramedullary pressure alone, of bacteria alone, and of the combination of the two might be studied in different ribs on the same animal. The chief disadvantage of this method of study would seem to reside in the fact that osteomyelitis of ribs is rare in the human. It is the purpose of the present paper to report the results of these studies.

METHODS

Dogs were used in all studies. Elevated intramedullary pressure was produced by the injection of 0.9 per cent saline solution at various pressures through a needle which was inserted obliquely into the costal cartilage and across the costochondral junction into the medullary canal of the tip of the rib. The experiments may be divided into five groups.

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Group I included studies on ribs during and immediately after increased intramedullary pressure maintained for periods up to twenty-four hours. In Group II, following a period of elevated intramedullary pressure, the animals were allowed to recover and the ribs were studied after varying intervals. Group III included the studies on ribs in which cultures of staphylococci were injected through a needle into the medullary canal near the tip of the rib. In Group IV a period of elevated intramedullary pressure was followed by the injection of a culture of staphylococci through the needle. Group V included experiments in which, following elevated intramedullary pressure by the injection of salt solution, organisms were injected intravenously. After sacrificing the animal, the ribs were removed, x-rayed, sectioned, and examined both grossly and microscopically. By the use of several ribs in the same dog for different types of experiment, results could be compared in the same animal.

Animals were anesthetized by nembutal given intravenously (25 mg. per kilogram). Using aseptic precautions, a small incision was made over a selected costochondral junction and the muscles were separated, thus exposing the tip of the rib and costal cartilage. A No. 20 gauge spinal needle with stylet in place was pushed into the cartilage, beginning at a point about 5 mm. back from the costochondral junction, aimed in the longitudinal axis of the rib at such an angle as to pass across the costochondral junction into the center of the medullary canal, and down the canal for a distance of 5 to 10 mm. The incision was closed tightly in layers about the needle with fine black silk. A reservoir of sterile 0.9 per cent saline solution was connected to the needle, placed at the desired height to give various hydrostatic pressures, and maintained at that level for varying periods of time, from sixteen to thirty-three hours. Additional nembutal and morphine were given as required during the course of the experiment to keep the animals free of pain.

The organisms used were eighteen-hour broth cultures of staphylococci supplied by Dr. R. H. Rigdon, of the Department of Pathology. Strain 7 is a nontoxin-producing *Staphylococcus aureus;* Strain AO produces a potent exotoxin, capable of producing marked tissue necrosis as demonstrated by Rigdon.[2] Both strains have been maintained for several years at a fairly constant level of virulence by culture on artificial media.

RESULTS

Group I. The Immediate Effects of Elevated Intramedullary Pressure Produced by the Injection of Saline Solution.—The immediate effects of elevated intramedullary pressure have been studied on twenty ribs of seven pups and eleven ribs of four adult dogs. In some of these experiments the wounds were left open and coloring material added to the saline solution, so that its course might be followed. Immediately after beginning the injection at pressures of 100 to 200 cm. of saline solution,

blood in the intercostal vessels was seen to be displaced by saline solution. Within one to two minutes, dye appeared in the cortex of the rib overlying the point of the needle, coloring the 1 or 2 cm. next to the cartilage. In the course of several hours the amount of color in the bone increased and spread to the periosteum overlying the stained portion of the rib. In six to twelve hours edema and hyperemia of the periosteum were noted, both in pups and adult dogs. At the end of sixteen to twenty-four hours, in two-thirds of the pups and one-third of the adult dogs the periosteum was found to be separated from the rib by salt solution. This separation in some instances included the whole circumference of the rib. More often the periosteum was separated on only a portion of the circumference, in which case it was usually the pleural surface which was stripped. The stripping extended longitudinally from the costochondral junction for a variable distance, usually 2 to 4 cm., but in some experiments extended back almost to the vertebral end. The amount of periosteal stripping was not dependent upon the amount of saline solution infused. Stripping occurred in pups with amounts of salt solution as small as 20 c.c. or as great as 700 c.c. The actual amount of saline solution infused probably depended upon the relation of the point of the needle to vascular spaces, or spicules of bone. As stated, periosteal stripping occurred more frequently and apparently more easily in pups than in adults. It has been noted in pups that the periosteum is thicker, more vascular, and more readily separated from the bone by other mechanical means. The combined layer of periosteum and pleura dissected up on the pleural surface of the rib by the saline solution occasionally ruptured and allowed saline solution to fill the pleural cavity. This occurred in four of the pups used in these experiments, with pressures of 130 to 225 cm. of saline solution. Periosteum has been found to be stripped in pups at a pressure of 91 cm., this being the lowest pressure tried. The bone from which periosteum had been stripped had a slightly rough, dull appearance, and, with continued pressure in the medullary canal, fluid came through the cortex in tiny beads in the ribs of pups. In adults the openings in the cortex where the periosteal vessels had been torn off were larger and fluid ran through more freely.

The injected salt solution did not flow freely down the medullary canal. If, while it was being injected, the rib was cut across near the vertebral end, no solution flowed from the medullary canal. If only 3 to 4 cm. of marrow intervened between the needle and the open end of the rib, saline solution then ran from the cut end.

In order to try to determine whether the separation of the periosteum was a mechanical process or a reaction of the living periosteum, similar experiments were done after death of the animal. In ribs in which elevated intramedullary pressure was produced by the injection of salt solution, beginning immediately after the animal's death, edema and

separation of the periosteum occurred with the same pressure and after the same time interval as in the living animal.

Group II. The Later Effects of Elevated Intramedullary Pressure.—In a total of ten ribs of ten pups, pressures of from 104 to 225 cm. saline solution for sixteen to thirty-three hours gave essentially the same response. After two days it was found in one rib that the thickened, red periosteum about the tip of the rib was detached for 2.5 cm., separated from the rib by a reddish thick exudate containing many polymorphonuclear cells on smear, but no organisms. The bare bone was lusterless and finely pitted, with a brown necrotic marrow in its distal 3 cm. In another rib, ten days after increased pressure, the periosteum was thickened, with an underlying zone of soft granulation tissue from which the

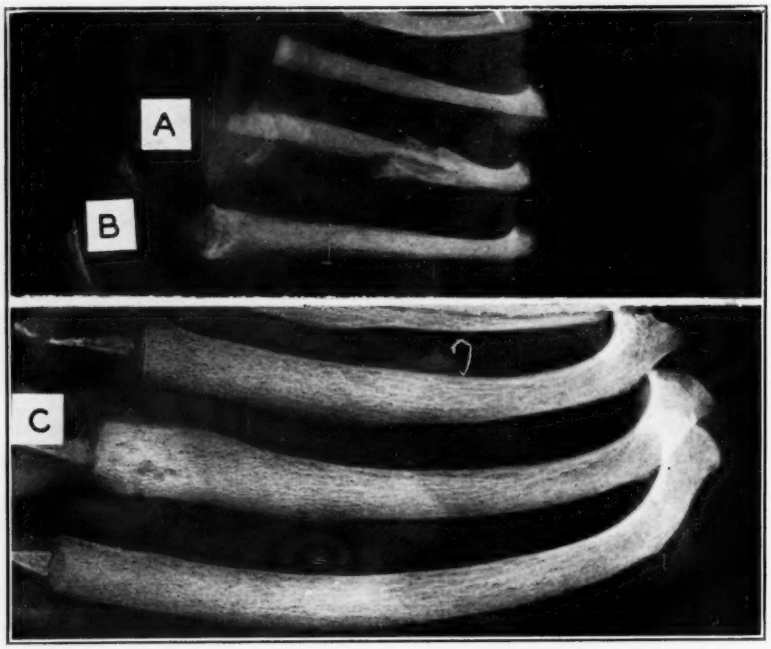

Fig. 1.—X-rays of ribs. *A*, Pup rib twenty-three days after elevated intramedullary pressure of 156 cm. for seventeen hours, followed by 1 c.c. of a culture of toxin-producing *Staphylococcus aureus*. Destruction of the rib at the tip with dislocation of the costochondral junction is seen. The destruction and new bone formation in the middle third of the rib is unusual, being limited usually to the tip. *B*, Pup rib twenty-nine days after elevated intramedullary pressure of 156 cm. of saline solution for ten hours. New bone is present about the tip of the rib. *C*, Adult rib thirteen days after the injection of 0.25 c.c. of toxin-producing staphylococcus culture into the rib. Destruction of areas of bone but little or no deposition of new bone has occurred.

rib could be rather easily peeled out. The rib was porous and brittle, sections showing necrosis of the marrow and cortical bone. Eight ribs of pups examined after ten to twenty-nine days demonstrated a fairly uniform picture. A layer of firmly attached periosteal new bone surrounded the rib, with new bone widening the costochondral junction. The marrow was brownish yellow in color. X-ray films demonstrated the shell of new bone about the rib and widening of the junction with the

cartilage (Fig. 1 *B*). In all cases the new bone was tightly adherent to the rib, without sequestration. In sections through these ribs there was necrosis of the marrow cells and a replacement by fibrous tissue. Variable amounts of cortical and medullary bone were necrotic as judged by absence of cells in the lacunae and altered staining reaction of the bone. The periosteum was thickened, with new bone laid down about the old cortex and larger amounts of bone about the costochondral junction (Fig. 2).

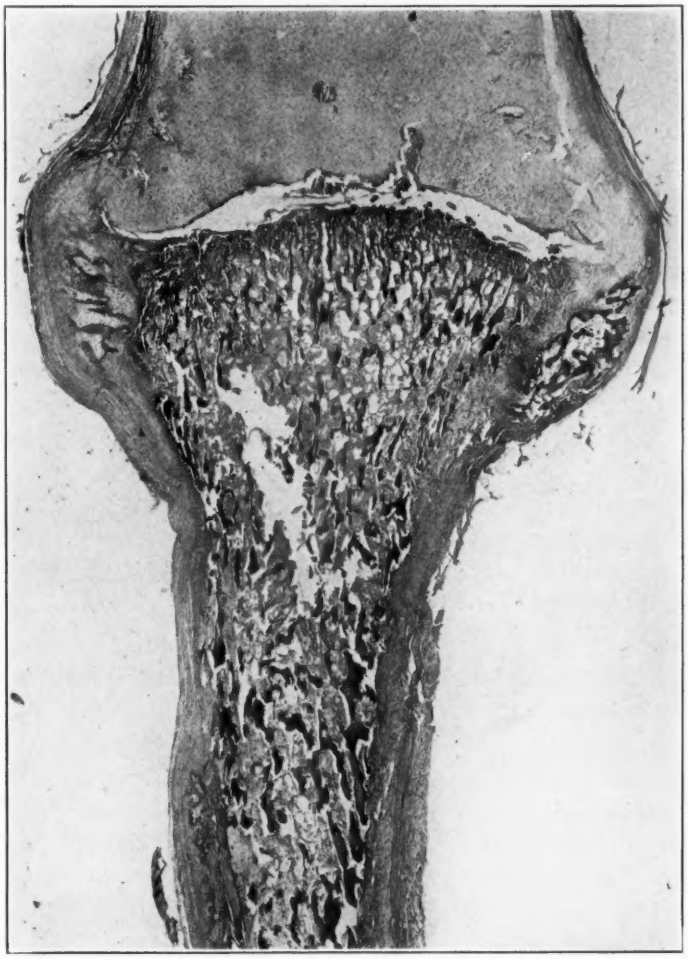

Fig. 2.—Section of puppy rib fourteen days after elevated intramedullary pressure of 225 cm. of saline solution for eighteen hours. There is replacement of marrow cells by fibrous tissue and fat, necrosis of medullary and cortical bone, with new bone in the adherent periosteum. (×16.)

In the eight ribs of the adult dogs similar changes of lesser grade were seen; in some, the bone necrosis and new bone formation were so slight as to be negligible.

Group III: The Effects of Injection of Organisms Into the Medullary Canal.—As stated before, broth cultures of staphylococci were injected

into the medullary canal of ribs, close to the costochondral junction, through a needle inserted as described.

In eight ribs of four pups 0.25 to 2.0 c.c. of an eighteen-hour broth culture of Strain 7 (nontoxin-producing) *Staphylococcus aureus* was injected, and the ribs studied after seventeen to forty-two days. No change could be detected in these ribs, and the organisms caused no other lesions in the animals.

In fourteen ribs of eight pups 0.2 to 1.0 c.c. of an eighteen-hour broth culture of Strain AO (toxin-producing) *Staphylococcus aureus* was injected. Six of the pups died in from one to seven days, exhibiting focal necrosis and hemorrhages in the kidneys and mucosal hemorrhages in the colon. One pup dying after twenty-four hours showed no gross changes in the rib. In those dying after two to seven days there were edema and necrosis of the muscle tissue overlying the rib and separation of the costochondral junction. The periosteum was red and edematous for 2 to 4 cm. and separated from the rib for a few millimeters at the costochondral junction, but it usually was not stripped further than this. However, it could be easily removed. The marrow was moist and soft and the tip of the rib appeared porous and necrotic. Microscopic examination of these ribs four to six days after injection demonstrated an area of acute necrosis of the marrow tissue, only a few pyknotic nuclei remaining in a mass of debris. There was destruction and absorption of the columns of ossifying cartilage, so that a line of separation was formed between the costal cartilage and the tip of the rib. The necrosis present in the marrow extended through the Haversian canals of the cortex to involve the periosteum. The necrosis and inflammatory process extended outside the cortex along the periosteum (Fig. 3).

The ribs of pups surviving longer after the injection of organisms showed evidences of repair, with absorption of necrotic bone and deposition of new bone. After ten days, as seen in one rib on x-ray examination, there was a moth-eaten appearance of the tip of the rib, which was surrounded by a thin shell of new bone. Grossly, the end of the rib was enlarged and hyperemic, the marrow soft, brown, and necrotic, with a layer of new bone about the cortex. Microscopic sections showed much new bone about the medullary canal, with very little remnant of the old cortex at the tip of the rib and a collection of leucocytes in the medulla near the costal cartilage. The columns of ossifying cartilage were completely absent. After twenty-five days, there was further deposition of bone about the tip of the rib, ossification along the costochondral junction occurring from its periphery, the center being occupied by gelatinous granulation tissue.

Organisms of the AO strain (toxin-producing) were injected into a total of six ribs in five adult dogs, 0.25 to 0.5 c.c. being injected. None of the dogs died following injection of the organisms, and but one wound broke down and drained. These ribs were examined after thirteen to

thirty-nine days, less change being seen than in the ribs of pups. On x-ray examination, a slight to moderate absorption of bone in or close to the tip of the rib was seen, with decreased bone density in areas and only a small amount of new bone about the tip of the rib (Fig. 1 *C*). On gross section, the marrow close to the rib tip was brown, with small amounts of grayish soft tissue in the junction of rib and cartilage and a very thin zone of periosteal new bone. The microscopic appearance was similar to that seen in pup ribs.

Fig. 3.—Section of puppy rib four days after injection of 0.25 c.c. of a culture of toxin-producing staphylococcus. There is necrosis of the marrow and absorption of the columns of ossifying cartilage, leading to separation of the costochondral junction. The necrosis extends through the cortex to involve the periosteum. (×24.)

Group IV. The Effects of Increased Intramedullary Pressure With Infection.—In view of the periosteal bone formation without sequestration in response to increased intramedullary pressure alone, the effect of injecting organisms into the rib after saline pressure had been exerted in the medullary canal for some hours was studied. Saline pres-

sure of 156 cm. was used throughout these experiments, exerted for sixteen to twenty hours. Immediately after disconnecting the pressure bottle from the needle, organisms were injected and the needle removed. One rib of each of four pups was studied after 156 cm. pressure had been exerted for sixteen to eighteen hours followed by the injection of 0.5 to 1.0 c.c. of AO (toxin-producing) staphylococcus. In one pup

Fig. 4.—Section of adult rib two days after increased intramedullary pressure of 156 cm. for eighteen hours, followed by 1 c.c. of toxin-producing staphylococcus culture. Necrosis of marrow, cortex, and overlying periosteum is present, with infiltration of the periosteum by leucocytes beyond the areas of acute necrosis. (×16.)

dying after two days, red, thickened periosteum was detached from the rib on the pleural surface for 4 to 5 cm. from the costochondral junction, and the costochondral junction was separated. Microscopic section demonstrated an acute necrosis of the marrow tissue, absorption of the columns of ossifying cartilage, producing a separation of bone and cartilage, and an acute inflammatory reaction in the periosteum which

was detached from the cortex. After eighteen and twenty-three days, x-ray examination demonstrated a spotty moth-eaten appearance, usually of the distal 2 to 3 cm. of the rib and a thick shell of new bone about it (Fig. 1 *A*). After forty-three days, a thick shell of involucrum was present with apparently complete resorption of the old cortex near the tip of the rib. In sections of these ribs there was a very ir-

Fig. 5.—Portion of Fig. 4. (×48.)

regular and widened line of ossification at the cartilage and formation of new periosteal bone. The cortex and cancellous bone were necrotic, as was the marrow near the tip of the rib. The necrotic bone in places was separated by granulation tissue from involucrum, but in others it was intimately attached to periosteum in which new bone was being deposited along the necrotic cortex.

Three pups received 0.5 to 1.0 c.c. of broth culture of Strain 7 (non-toxin-producing) staphylococcus following a similar period of elevated

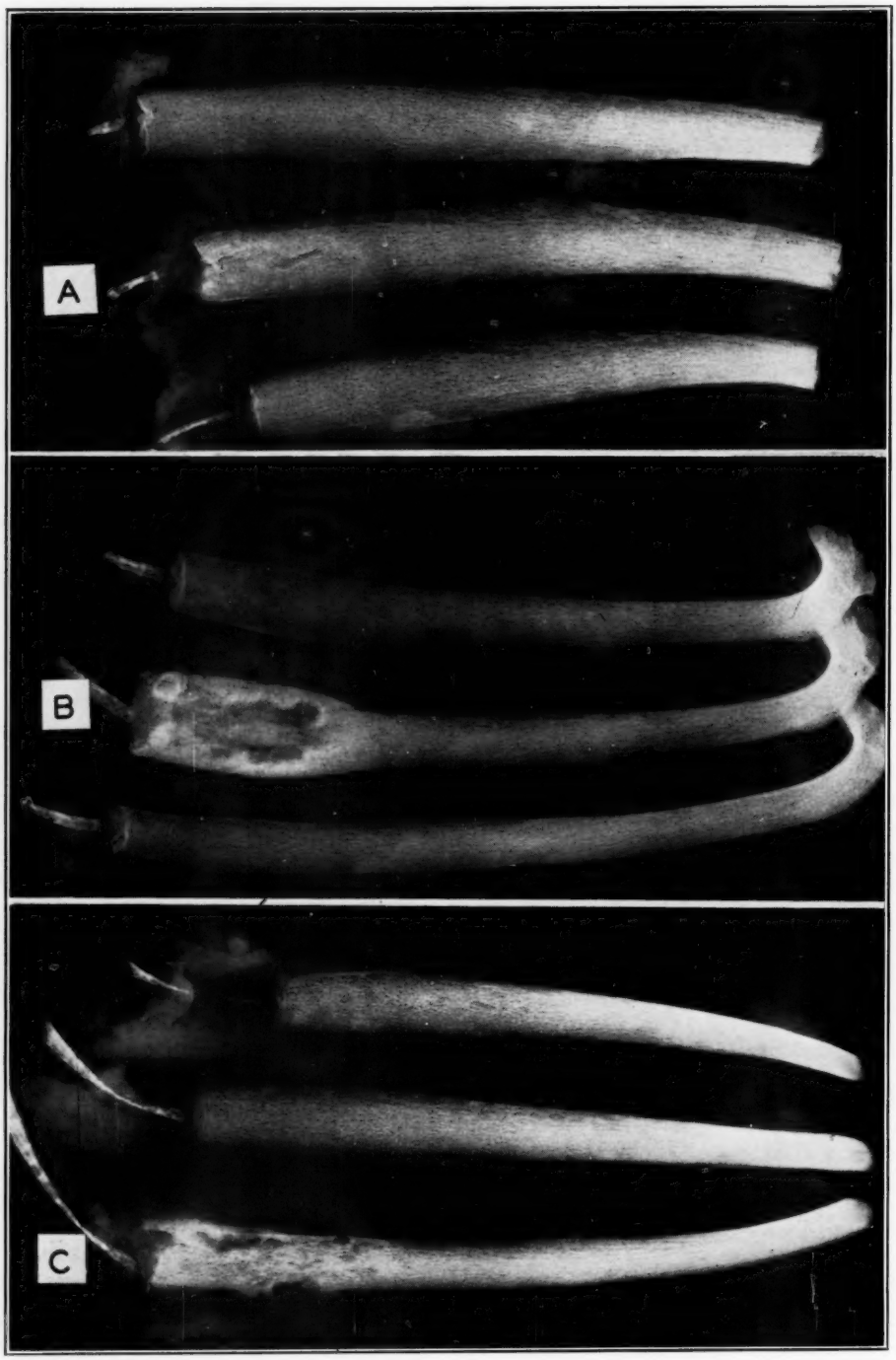

Fig. 6.—*A*, X-ray of adult ribs forty-one days after increased intramedullary pressure followed by 1 c.c. of nontoxin-producing staphylococcus culture. There is a small area of rarefaction, surrounded by bone of increased density. *B*, X-ray of the same rib as shown in Fig. 7 to show the bone destruction, involucrum, and sequestration. *C*, X-ray of adult rib nineteen days after elevated intramedullary pressure followed by the intravenous injection of toxin-producing staphylococci. The amount of bone destruction and new bone formation is evident.

intramedullary pressure. When sacrificed after twenty-four to forty-one days, these ribs showed some increase in density and thickness of the cortex. There was irregularity of the costochondral junction, such as was seen with pressure alone, but without the bone destruction occurring after toxin-producing organisms.

Fig. 7.—Cross section of adult rib twenty-seven days after elevated intramedullary pressure followed by injection of toxin-producing organisms. The large amount of new bone and a small bit of free, sequestrated bone are shown. (×17.)

Increased intramedullary pressure of 156 cm. of saline solution maintained for sixteen to twenty hours was followed by 0.25 to 1.0 c.c. of toxin-producing staphylococcus culture in a total of eight ribs of six adult dogs. One wound opened and drained for two months. In one dog dying on the second day, an area of periosteum and pleura measuring 1 by 2 cm. was grossly necrotic, exposing bare bone, with the surrounding periosteum red and edematous. Microscopically (Figs. 4 and

5), the marrow proximal to the rib tip was acutely necrotic, with absorption of the cancellous bone and necrosis and early absorption of an area of cortex. The periosteum over this cortex also showed necrosis. More peripherally the periosteum was filled with polymorphonuclear leucocytes, separating periosteum and cortex. A similar process was seen in another rib after nine days, with the addition of beginning periosteal new bone formation in the less damaged periosteum. With longer periods of ten to forty-one days, increasing amounts of new bone were produced by the periosteum with resorption of some of the necrotic bone and sequestration of smaller portions (Figs. 6 *B* and 7). The amount of destruction in the ribs is variable. As seen by x-ray, some show extensive destruction of bone, extending from the tip almost to the vertebral end of the rib, with large amounts of involucrum; while others show only a tiny area of rarefaction near the cartilage junction and a minimum of new bone.

Nontoxin-producing staphylococci were similarly injected following a period of increased intramedullary pressure in five ribs of five adult dogs and examined after a period of thirty-four to fifty days. In three there was no demonstrable change and two showed slight thickening of the cortex with irregularity of the costochondral junction (Fig. 6 *A*).

Group V. The Effects of Increased Intramedullary Pressure and Intravenous Organisms.—A group of six experiments was done in which elevated intramedullary pressure, by the injection of saline solution into the rib, was maintained for sixteen to twenty hours at a pressure of 156 cm. and followed immediately by the intravenous injection of 0.25 to 1.5 c.c. of a broth culture of the toxin-producing staphylococcus. The wounds in these dogs healed without drainage; none of the dogs died as a result of the injection; and there were no other lesions noted at autopsy aside from the changes in the ribs. The dogs, one pup and five adults, were sacrificed after eleven to twenty-one days. One rib was only slightly altered in structure; the other five all showed enlargement of the tip of the rib and, on x-ray, a spotty destruction of the cortex and medullary portion of the distal few centimeters of the rib, with the formation of new bone about it (Fig. 6 *C*). The amount of bone destruction and new bone formation was as great as in those ribs in which the organisms were implanted directly, and much greater than in any of the ribs in which only increased intramedullary pressure was produced.

DISCUSSION

The difficulty in producing in experimental animals a process corresponding with acute hematogenous osteomyelitis of human beings is indicated by the numerous and varied methods which have been used in attempts to reproduce this disease. Rodet[3] obtained abscesses in bone, without trauma, by the intravenous injection of staphylococci. Lexer,[4] Robertson,[5] and, more recently, Thompson and Dubos[6] produced staphy-

lococcal infections in the metaphyses of long bones of young animals by the intravenous injection of organisms, without, however, reproducing the massive necrosis and sequestration seen in human osteomyelitis. Starr[7] produced an experimental osteomyelitis by the injection into the nutrient artery of a mixed culture of organisms, but death of the animals occurred within forty-eight hours and only very early stages could be studied. Bancroft[8] produced a chemical osteomyelitis by the introduction of croton oil into the medullary canal of long bones and Phemister[9] similarly produced necrosis by radium. Haldeman[10] produced osteomyelitis by introducing staphylococci through a drill hole in the cortex near the metaphysis. Baudet and Cahuzac[11] stated that they were unable to cause a true osteomyelitis by the intramedullary, subperiosteal or intravenous injection of staphylococci.

It has been amply demonstrated by the researches of Axhausen,[12] Brunschwig,[13] Nussbaum,[14] and Kistler[15-17] that necrosis of bone does not lead to sequestration but to the production of new bone and gradual absorption of dead bone. When necrosis and infection are both present, not all the dead bone is sequestrated, only that part most severely damaged.

By a combination of elevated intramedullary pressure and infection, massive necrosis and sequestration of diaphyseal bone, which very closely resemble that occurring in human osteomyelitis, have been produced by Larsen.[1] The experiments described in the present paper demonstrate that cortex and marrow may be killed and periosteum separated by increased intramedullary pressure. However, in the absence of infection, periosteum reattaches and new bone is laid down, substituting the necrotic bone without sequestration.

In our experiments the combination of necrosis of bone produced by elevated intramedullary pressure and the presence of virulent organisms, whether implanted directly or localized from the blood stream, does lead to sequestration. The sequestra, however, need not be extruded but are absorbed in situ. In Larsen's experiments primary stripping of periosteum was not a factor in the necrosis of bone, but in the presence of dead, infected bone periosteum separated and sequestration ensued. In the present experiments the stripping of rib periosteum by the saline solution is probably to be accounted for by the thin cortex, with large soft tissue and vascular spaces near the costochondral junction. Combined with the presence of large amounts of cancellous bone in the medulla, these factors direct the flow of saline solution through the cortex rather than down the medullary canal, as noted, with pressure concentrated in a small area of rib. By seepage of saline solution through the walls of the perforating periosteal vessels as they enter the cortex, saline solution may produce slight separation of the periosteum from the cortex. As this continues, these vessels are stretched and finally

torn across, so that saline solution may run freely from the cortex, beneath the periosteum, to strip it up.

The direct mechanical stripping of the periosteum by saline solution occurs at pressures which are probably much higher than any ever reached in the bone through infection. The separation of periosteum in the presence of infection, as seen in the microscopic sections, appears to be due to necrosis of the inner layer of periosteum, caused by a spread of bacterial toxin from the medulla through the cortex. As has been pointed out by Larsen, it is doubtful that the separation of the periosteum plays a great part in killing the underlying cortex by interfering with its blood supply.

The importance of the toxin elaborated by the staphylococcus in the production of necrosis of bone again is emphasized in these experiments, as has been pointed out by Stookey and co-workers[18] and by Robertson.[19] We have shown that nontoxin-producing organisms are well tolerated by ribs and cause no destruction of bone. The combination of increased intramedullary pressure and nontoxin-producing organisms results in hardly more alteration in the rib than the pressure alone. Toxin-producing staphylococci do cause necrosis of bone and marrow and, when combined with the necrosis succeeding upon elevated intramedullary pressure, cause extensive necrosis and sequestration, which greatly resemble human osteomyelitis. A remarkable fact is the rarity of a spontaneous draining sinus in these experiments and the readiness with which necrotic and even sequestrated bone can be absorbed in the rib. Green and Shannon[20] comment on the fact that in infants acute osteomyelitis is less chronic and it is less usual for sequestration to occur, explaining these observations on the greater vascularity and spongy quality of infants' bones, factors which are also present in ribs.

SUMMARY

Increased intramedullary pressure, produced by the injection of salt solution into the ribs of dogs, leads to marrow and bone necrosis, with subsequent new bone formation, but without sequestration. Toxin-producing staphylococci cause necrosis of marrow and bone. Elevated intramedullary pressure caused by the injection of saline solution combined with toxin-producing staphylococci results in extensive bone necrosis and sequestration. In ribs sequestrated bone may be absorbed without the formation of a sinus or the extrusion of the sequestrum.

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TUMORS OF THE SALIVARY GLANDS*

I. A Review of Prognostic Data From the Literature

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FOR MANY years the difficult clinical and pathologic problems of tumors in the region of the salivary glands have attracted great interest. Investigations prior to the past decade have been largely directed toward a study of pathogenesis, but more recently follow-up studies with emphasis upon the clinical course have been reported.[1, 2, 4, 6, 9, 10, 13, 14, 18, 19, 20, 22] Pathologists, surgeons, and radiologists have recorded divergent views in regard to treatment, and the results of treatment by any means have been sharply criticized.[13, 14] It is therefore of interest to assemble and correlate the available clinicopathologic data as an aid in formulating a rational therapeutic plan.

The comprehensive monograph of Ahlbom, of Radiumhemmet, Stockholm, deserves especial consideration since it provides a vast sum of information derived from a complete review of previous publications along with a study of 254 salivary tumors. Since this work summarizes a wide experience with radiotherapy and is not generally available in this country, material has been freely drawn from it in the preparation of this paper.

An evaluation of the prognostic data in the literature is impeded by the lack of uniformity in pathologic nomenclature and classification, particularly with regard to malignancy. For this reason, along with the fact that pathology, treatment, and prognosis are interrelated in subject matter, a brief summary of pathology and treatment is presented.

PATHOLOGY

A variety of benign and malignant neoplasms occur in and about the salivary glands. Among the benign tumors are included angiomas, lipomas, and fibromas similar to those found elsewhere but of infrequent occurrence. Pure adenomas rarely have been described and their existence is doubted.[1, 11] The adenolymphoma (onkycytoma), structurally a benign papillary cyst containing lymphoid tissue, is infrequently encountered.[3]

By far the greatest number of all salivary tumors are included in the so-called mixed tumor group. Varying greatly in structure and behavior, these bizarre, composite tumors may show either benign or malignant

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characteristics. Whatever its histogenesis, a mixed tumor apparently consists of both epithelial and connective tissue elements. Collections of epithelial cells with a variable cytology and arrangement are included in a mucinous, fibromyxomatous, or even myxocartilaginous stroma. The epithelial cells are for the most part glandular, but basal cell and squamous cell types, even epithelial pearls, may be included.

Most salivary tumors of clear-cut malignancy are considered to be adenocarcinomas, although the distinction between adenocarcinomas and malignant mixed tumors is not always well defined. Cuboidal cell cancer, said to arise from the small ducts, and a rare type of cancer composed of small spindle and round cells (small cell carcinoma of Chevassu) are recognized, and a basal cell type of carcinoma which must be distinguished from the typical mixed tumor has been discussed.[1, 22] Squamous cell carcinoma may be found in a typical mixed tumor, but squamous cell carcinoma growing in the salivary glands may represent metastasis to lymph nodes from the nasopharynx or branchiogenic carcinoma with secondary invasion of the gland.

Sarcoma is unusual in the salivary glands since the glands are primarily composed of epithelium. Malignant melanoma, lymphosarcoma, and other varieties of sarcoma probably arise from the lymph nodes and fibrous tissues in and around the glands and should not be considered true salivary tumors.[1]

HISTOGENESIS

Numerous theories of derivation have been advanced, attempting to explain the varying types of epithelium and stroma of mixed tumors. The earlier theories of endothelial and connective tissue origin have been generally abandoned. The prevailing theories may be summarized:

1. Single tissue origin:
   a. From the epithelium of the salivary or mucous glands.
   b. From detached salivary gland anlage formed during the invagination of the buccal epithelium.
2. Dual tissue origin:
   a. From branchial cleft inclusions (three germ layers).
   b. From embryonal nonbranchial anlage (ectoderm and mesenchyme).

The theories of dual tissue origin most easily explain the fibroepithelial components as well as the not uncommon finding of composite tumors at the sites of union of branchial clefts and embryonal facial fissures. Recently, a relationship of anatomic distribution between basal-cell carcinomas and mixed tumors of the face with respect to embryonal facial fissures has been presented,[16] adding support to the view of embryonal origin.

On the other hand, proponents of the epithelial, single tissue origin explain the myxomatous and cartilaginous stroma as due to the mucous secretion of the epithelial glandular cells with "immersion" of the

intracellular fibrous stroma and subsequent hyalinization. This view presupposes that composite tumors of the oropharynx, face, lachrymal glands, and other regions arise from the small mucous, salivary, and lachrymal gland epithelia or their anlage.

The possibility that tumors generally included in the mixed tumor group may arise from several sources has ben suggested.[6, 8] Several recent studies have indicated that the intraoral tumors are less complex than those occurring about the face, neck, and scalp.[1, 8, 18] The extraoral tumors are said to be derived from ectodermal inclusions formed in fusion of the branchial clefts and fissures, and the intraoral tumors formed during the invagination of the oral ectoderm in the development of the normal salivary and mucous glands.[8]

CLASSIFICATION

With most of the pathologic and clinical problems centering upon the so-called mixed tumor group, the lack of a standard nomenclature and classification retards an accurate therapeusis and prognosis. Descriptive terms have been applied to individual mixed tumors in the past. At present, the general tendency is to group them on a histogenetic basis, with a simplified nomenclature. The term mixed tumor is applied to composite tumors if a dual tissue origin is accepted, and mucous and salivary gland tumors if a single tissue, epithelial origin is preferred. Confusion still exists, however, since:

1. Theories of histogenesis have been inconclusive.
2. The histologic structure varies widely and the personal equation enters into any histologic grouping (Table I).
3. Microscopic differentiation of the benign from the malignant is frequently impossible.[12]
4. The clinical behavior of individual tumors is quite variable, and often does not conform to the microscopic picture.[12-14]

TABLE I

COMPARISON OF PATHOLOGIC GROUPINGS

	TOTAL CASES	MIXED TUMORS			CARCINOMAS	SARCOMAS
		BENIGN	SEMI-MALIGNANT	MALIGNANT		
Martin and Elkin[9]	24	11		10	3	
Schreiner and Mattick[20]	48	37			11	1
Wakeley[24]	52	40			12	
Benedict and Meigs[2]	78	39			30	9
Stewart[23]	28	12		8	8	
Patey[18]	52	29	15	8		
Stein and Geschickter[22]	241	199			42	
Ahlbom[1]	214	80	37	30	61	6
Houck*	48	25		12	9	

*See Part II, SURGERY 6: 565, 1939.

Efforts to obtain a pathologic classification of salivary tumors which will indicate the clinical course and prognosis in individual cases have

been made with poor success. After reviewing the efforts of previous investigators in attempting to determine the malignancy of the so-called mixed tumors, MacFarland[13, 14] concluded that "the microscope, beyond showing that the lesion is a mixed tumor, is misleading rather than enlightening." He decided that "structure and duration have to be considered together, both in making the diagnosis and in deducing a prognosis." He classified salivary tumors simply as mixed tumors and carcinomas. All mixed tumors were considered "potentially malignant."

Stein and Geschickter[22] singled out the character of the stroma as the most reliable microscopic index of a benign tumor: "The slower the rate of growth, the larger the amount of stroma and the more often is cartilage found." A basal cell type was distinguished from the typical mixed tumor. Three types of carcinoma were noted.

Martin and Elkin[9] recognized two groups of salivary tumors. The first is characterized by long duration, mobility, and a sharp outline with a well-formed capsule. The stroma is thick and hyalinized, and cartilaginous tissue is frequent. Epithelial cells are dark and polyhedral, in cords. In the second group, encapsulation is usually present, but the tumor is fixed. The tissue is soft and the cells are hyperchromatic and more uniform, with attempts at gland formation and scanty stroma. The latter group was judged to be of more active growth.

Patey[18] studied fifty-five cases of tumors of the salivary glands, including similar tumors found about the face and oropharynx, and classified them in four groups on the basis of cellularity. The clinical results were compared with the histologic grading and malignancy apparently varied directly with the degree of cellularity and dedifferentiation of cells.

Ahlbom[1] prefers the term mucous and salivary gland tumors, to include all tumors of the large salivary glands as well as similar tumors occurring elsewhere about the head and neck. In his classification, the use of descriptive terms demonstrates the relation of structural components to malignancy. The terms basalioma, cylindroma, and adenocystic basal-cell epithelioma are more or less synonymous, but Ahlbom has restricted the term basalioma to benign or malignant tumors resembling basal-cell cancer. This classification, which was developed by Reuterwald, of Radiumhemmet, appears on page 554.

The basis of classification of Ahlbom's three subgroups appears on page 554.

Polymorphous and atypical cells are concepts which in the above scheme mean that the cells show a marked irregularity in comparison with the cells in benign mixed tumors. The benign tumor contains cells which are atypical and polymorphous but to a lesser degree and arranged in characteristic architecture. A relative degree of variation in the cells must be determined. In semimalignant tumors, features resembling infiltrative growth may be found. Tumor cells may lie

adjacent to nerves, blood vessels, and muscle, but an impression of a tendency toward encapsulation is obtained. Stricter rules in regard to infiltrative growth must be used in mixed salivary tumors in comparison to tumors in general, since the benign salivary tumors will invade the capsule to some extent.

CLASSIFICATION OF AHLBOM

		NO. OF CASES
A. Benign tumors		
1. So-called mixed tumors		76
Fibromyxoepithelial	33	
Fibroepithelial	1	
Fibromyxochondroepithelial	42	
2. Adenoma		2
3. Papillary cystic adenoma		1
4. Basalioma (with cylindromatous features)		1
Total		80
B. Semimalignant		
1. So-called mixed tumors		25
Fibroepithelial	4	
Fibromyxoepithelial	17	
Fibromyxochondroepithelial	3	
Fibromyxoma (without definite epithelium)	1	
2. Papillary cystic adenoma		7
3. Basalioma		5
With cylindromatous features	3	
Solid	2	
Total		37
C. Malignant		
1. So-called mixed tumors		34
Fibroepithelioma	14	
Fibromyxoepithelioma	11	
Fibromyxochondroepithelioma	5	
Fibromyxosarcomatous (without epithelium)	4	
2. Predominantly adenocarcinomatous type		7
3. Predominantly papillary cystic		10
4. Predominantly basal-cell type (cancer)		29
With cylindromatous features	23	
Solid	6	
5. Of predominantly squamous-cell cancer type		4
6. Slightly differentiated or undifferentiated epithelial		11
7. Slightly differentiated or undifferentiated without epithelial structures		2
Total		97

BASIS OF CLASSIFICATION OF AHLBOM'S SUBGROUPS

A. Malignant tumors
   1. The presence of metastases
   2. Infiltrative and destructive growth, with no tendency toward encapsulation

B. Semimalignant tumors
   1. A complete capsule in which there may be tumor nodules if the tumors are:
      a. Cellular and little differentiated with sparse intercellular substance
      b. Distinguished by cells which are atypical and polymorphous, with hyperchromatic or polymorphous nuclei, perhaps with a noticeable number of mitoses
      c. Basaliomas (with or without cylindromatous features) which have a structure suspicious of malignancy
      (Some of these features may be found together in the same tumor)
   2. Tumors which present nodules outside the capsule or which have broken through the capsule, but still show a tendency toward encapsulation

C. Benign tumors
   Encapsulated tumors which exhibit none of the above features
   Nodules in the capsule with a benign structure or similar nodules outside the capsule, if provided with their own well-formed capsule, do not prevent tumors from being placed in this subgroup

HISTOLOGIC CRITERIA OF MALIGNANCY

In reviewing the assembled schemes of classification, it appears that clear-cut benign and malignant groupings are frequently unsatisfactory. A borderline group (or groups) of relatively low-grade malignancy is usually recognized. Accordingly, microscopic criteria of malignancy are only of relative value and each suggested criterion must be considered in the composite microscopic picture. No single criterion is strictly reliable except the typical histologic picture of undifferentiated pure carcinoma and the finding of metastases. The concept of relative malignancy must be kept constantly in mind. Microscopic features which have been used in determining the malignancy of salivary tumors in the quoted literature are summarized as follows:

1. Scanty stroma; lack of complex structure
2. Absence of cartilage-like tissue
3. Cellularity
4. Nuclear changes; polymorphism
5. Dedifferentiation of epithelial cells
6. Basal cell characteristics, usually adenocystic (Stein and Geschickter)
7. Papillary cystic structures (Ahlbom's tables)
8. Invasion of adjacent normal tissues
9. The typical picture of carcinoma
10. Metastases

AGE INCIDENCE

Salivary tumors may appear at any age. In Ahlbom's series, benign and semimalignant tumors first were noticed at an average age of 37 years, with the youngest at the age of 2 and the oldest at the age of 84 years. The average duration before coming to treatment was 7.1 years for the benign and 4.9 years for the semimalignant tumors of the salivary glands. The definitely malignant growths first were noticed at an average age of 46.5 years, with the average duration before treatment of 7.2 years. These figures, quoted from Ahlbom,[1] are in close accord with those of other observers.

CLINICAL COURSE

The typical mixed tumor of the parotid region is the prototype for salivary tumors, both in histologic structure and clinical course. The more benign tumor appears as a small pea-shaped nodule in the region of the gland, which usually progresses slowly to an irregular, rounded, nodular mass of firm consistency, attached to or embedded in the parotid gland. As a rule, the tumor is well circumscribed and movable, with no fixation to the skin or deeper soft tissues, and well encapsulated by a thick, fibrous capsule. Untreated, the more benign tumors may grow slowly for many years, reaching the size of a grapefruit or larger. Subjective symptoms are insignificant, although deeply situated growths

may produce pressure symptoms. The clinical course of Ahlbom's semimalignant group resembles that of the benign tumors. However, the rate of growth is somewhat more rapid, and partial or complete fixation to the deeper soft tissues is more common.

Malignant tumors are also irregular and rounded, but the consistency is more apt to be hard. In individual instances the consistency may be elastic or soft. Fixation to the skin and deeper structures is characteristic. Enlargement of the adjacent lymph nodes occurs, not always indicating metastatic involvement. In general, malignant tumors grow more rapidly, but salivary carcinomas grow more slowly than most carcinomas occurring elsewhere. The surrounding soft tissues and bony structures are invaded by direct extension. Subjective symptoms are more common than in benign tumors, due to invasion of the surrounding parts. Spontaneous facial paralysis is frequent. With invasion of the base of the skull, mandible, and oropharynx, extremely severe pain may develop, ranking with the most severe pain produced by any malignant tumor. Metastases occur late, indicating a relatively lower grade of malignancy than carcinomas in general. Death follows wide invasion of the neck and the base of the skull.

CLINICAL CRITERIA OF MALIGNANCY

1. *Age of the Patient.*—Malignant tumors occur at a somewhat later average age, but there is no sharp diagnostic distinction.

2. *Duration of the tumor* is not significant. The average duration is about the same for the benign and the definitely malignant growths.

3. *Rate of growth* is generally more rapid in definitely malignant tumors.[1] A tumor which reaches a size sufficient to bring the patient to operation within one year and which presents the microscopic picture of carcinoma offers a poor prognosis.[13]

4. *Acceleration of growth* has been mentioned[13] as possible evidence of activation of latent malignant tendencies.

5. *Subjective symptoms* are much more common in definitely malignant tumors.

6. *Spontaneous facial paralysis* is frequent in the malignant and rare in the benign neoplasms.[1]

7. *Location.*—Tumors of the oropharynx are less complex and more frequently malignant than those of the large salivary glands[4, 17] and should always be considered carcinomatous.[17]

8. *Consistency.*—The more malignant tumors are more often of a hard consistency, but this is not a reliable diagnostic distinction.[1]

9. *Mobility.*—The most obvious clinical difference between malignant and benign tumors is that most malignant tumors are fixed to the skin or deeper tissues and are seldom movable, while most benign tumors are freely movable.[1]

10. *Metastasis.*—About 20 per cent of malignant tumors of the large salivary glands present lymph node metastasis in the neck. Distant metastases are almost never demonstrable at the stage in which a patient comes to treatment.[1]

TREATMENT

The treatment of salivary tumors is particularly impeded by several factors:

1. A wide surgical excision of tumors of the neck may involve the sacrifice of nerves and blood vessels with resultant cosmetic disfiguration and functional disability.
2. Recurrence is frequent after surgical removal.
3. Salivary tumors are less radiosensitive than tumors in general.
4. The clinical and microscopic differentiation of benign from malignant tumors is not easy and at times impossible.
5. A satisfactory pathologic and clinical classification is lacking.

The traditional treatment has been surgical removal. Incomplete excision from fear of damage to the facial nerve or due to adherence of the tumor to the deep structures has made surgery too frequently ineffective. Radical operation produces facial nerve paralysis, while incomplete excision fails to cure the disease. The operation is usually more radical when a definite malignancy is suspected.

Since the microscopic diagnosis of malignancy is frequently inconclusive, preliminary biopsy is seldom justified. Violation of the protective capsule and operative trauma may increase the rate of growth and tendency toward invasion.[15] In view of the complex, variable tissue structure, a complete excision offers a better pathologic examination.[14] Benedict and Meigs[2] advocate immediate frozen section at the time of operation to determine the extent of the procedure; excision of the parotid gland, sacrifice of the facial nerve, and a complete neck dissection are done if the microscopic diagnosis is carcinoma.

Excision by sharp dissection is considered the best method of surgical eradication. Extracapsular enucleation by blunt dissection is widely practiced to avoid facial nerve injury, but recurrences are said to be more common than with excision; intracapsular curettage without removal of the capsule is not effective, since tumor cells are present in the capsule.[22]

The operative technique used by Hybbinette, of Stockholm, Sweden,[1] deserves special consideration. Small, well-encapsulated, freely movable tumors are excised or enucleated. In other cases, which generally might be considered inoperable, the capsule is incised and the tumor tissue removed from within the capsule with a spoon, with the wound protected from implantation of tumor particles. Afterwards, the capsule is dissected out by blunt instruments with one finger within the capsule, which is removed intact. The capsule, which usually contains tumor

cells, is said to be more completely removed by this method. Radiumhemmet cases operated on by this technique showed an insignificant frequency of recurrence (one in twenty-five) and no injuries to the facial nerve occurred. The use of preoperative x-ray therapy is said to facilitate removal of the tumor by surgery, due to edema of the fascial and fibrous tissues about the capsule which provide a good plane of cleavage. Operation does not carry increased danger of infection or delayed healing when it has been postponed until the radiation reaction is practically past, usually three to six weeks after conclusion of the preoperative radiation. This method is used for large or fixed tumors.

All types of external and interstitial irradiation have been employed in treating salivary tumors. Methods and dosage have not been standardized and have rapidly changed with the evolution of a more efficient radiologic technique. Although the results are frequently disappointing and the tumors relatively ray resistant,[1, 16, 20] good results are obtained in individual instances. Current opinion favors surgery as the chief reliance, to be supplemented by high voltage x-ray therapy or radium element packed in the surgical wound, with deep x-ray therapy used alone for large inoperable neoplasms. Interstitial implants of emanation or radium element have been largely abandoned[1, 11, 16] except in the treatment of an occasional small recurrence.

At the Radiumhemmet, Stockholm, Sweden, radiotherapy has been used for many years in the treatment of salivary tumors. Ahlbom[1] recently has reported the results of 254 cases treated at that clinic, with especial attention to the methods of radiotherapy. Intensive irradiation is said to bring about a decrease of size in these tumors, presumably acting upon the tumor epithelium for the most part. The response of the tumors to irradiation is quite variable, being greatest in the group of malignant tumors and in general being less in the semimalignant and least in the benign groups. About one-half of the most malignant tumors show no response. Individual tumors show a rapid response to radiation therapy. Ahlbom believes that the radiosensitivity of malignant salivary tumors is comparable to carcinomas of the breast and squamous cell cancers of the mouth, which are among the more radioresistant squamous cell cancers. Ahlbom has formulated the following plan of treatment:

1. Practically all cases should be treated. The only exceptions are patients with general debility or with visceral metastases, and very old patients with completely benign, very slowly growing tumors.

2. Treatment should be given at as early a stage as possible.

3. The treatment should be initiated with fractional external radiation. One may forego this radiation, however, in the case of clearly benign, slowly growing, superficially situated, and very easily enucleated tumors. When radiating the malignant tumors, the regional lymph node area should be included.

4. Tumors which prove themselves to be radioresistant (the majority) are radiated with moderate doses and then operated on if they are, or become, operable.

5. Operable and inoperable tumors which show themselves to be radiosensitive at the primary radiation, and where there is a prospect of cure without operation (as a rule, malignant tumors), should receive a large dose of external radiation or a smaller dose which is afterwards supplemented by intratumoral radium. It is wiser, however, to use irradiation combined with surgery for the most part in tumors of this type.

6. Other tumors (little radiosensitive or radioresistant, inoperable) are radiated for palliative purposes.

7. After operation on the benign and semimalignant tumors, radium should be placed in the wound cavity. Such treatment also can be used for malignant tumors, but there it is more important to give postoperative external radiation over the scar and its surroundings. In spite of the relatively rare occurrence of lymph node metastases, it must be considered safest to include the regional lymph nodes in the latter form of treatment.

8. In operations on tumors, especially malignant ones, in the oral cavity, upper respiratory passages, and middle ear, electroendothermy should be used if possible.

9. Lymph node dissection should not be done unless suspicious lymph nodes can be palpated and do not disappear after radiation.

10. Even if these principles are followed in the main, the treatment must always be individualized to a certain extent. In the individual case attention must be paid to the age and general condition of the patient, to his social conditions, to the situation, size, and extent of the tumor, to the presence of metastases, etc.

In Ahlbom's work the technique and dosage of x-ray and radium are described in detail. The principle of a preliminary therapeutic trial with irradiation is apparently of value.

PROGNOSIS

The following outline represents a digest of the reported experiences of various authors in regard to the apparent effect of different forms of treatment on the prognosis:

A. *Benign, Mixed Tumors*

1. *Untreated* (conservative treatment recommended by McFarland[13, 14]).

   a. *Life Expectancy.*—Most benign, mixed tumors grow slowly over a long period of years without endangering life, although many tumors which are microscopically b e n i g n exhibit rapid growth.[13, 14]

   b. *Symptoms and Disfigurement.*—Slowly growing tumors give almost no symptoms until a large size is reached, when pressure

on adjacent structures may cause discomfort. From fifteen to thirty years may be required for the growth to produce marked cosmetic disfigurement.

c. *Development of Malignancy.*—A small percentage of tumors which are at first apparently benign and slow growing later exhibit acceleration of growth and become invasive. Several explanations have been offered:

(1) A benign tumor undergoes malignant "degeneration."[5, 23]

(2) Such tumors are malignant or potentially malignant from the start.[1, 14, 17]

2. *Treated by Surgery* (generally considered the chief reliance).

a. *Life Expectancy.*—Usually a normal life span if the growth is properly excised. Repeated recurrences may end in destruction of life by invasion of the neck and head in instances in which the neoplasm was considered microscopically benign.[14]

b. *Recurrence of the tumor* can take place up to forty-seven years after removal and it thus is impossible to prove that any case is completely cured.[14]

TABLE II

BENIGN MIXED TUMORS—TREATED BY SURGERY ONLY

	FREQUENCY OF RECURRENCE
McFarland[14]	25%
Benedict and Meigs[2]	42.5%
Wood[25]	45%
Stein and Geschickter[22]	20%

Ahlbom[1] has estimated that from 20 to 25 per cent of benign tumors, treated by surgery only, recur within three years. The recurrence rate is lowest after excision, greater following enucleation, and greatest with intracapsular curettage without removing the capsule.[23] Hybbinette[1] has noted only 4.7 per cent recurrence after intracapsular curettage combined with immediate complete removal of the capsule (see previous description of technique).

McFarland[13, 14] has stressed the importance of waiting to remove a salivary tumor until it has reached the size of a lemon or greater (become "ripe"). In his series recurrence was more frequent when the tumor was removed while small.

TABLE III (AFTER MCFARLAND)

RECURRENCE OF SALIVARY TUMORS WITH RESPECT TO SIZE

SIZE	TOTAL NUMBER	RECURRENCE
Smaller than a walnut	28	32.1%
Walnut to lemon (inclusive)	109	17.4%
Larger than a lemon	19	10.0%

McFarland's tabulation represents the only attempt at clinical classification of operability in the literature. The table does not take into account the mobility or fixation of the neoplasm and gives no figures as to facial nerve damage with respect to size of the tumor. The findings are at variance with the surgical principle of removing a tumor at the earliest moment.

c. *Influence of Trauma on Rate of Growth.*—Incomplete excision may accelerate the rate of growth by removing or damaging the protective capsule.[9, 14, 22] It is doubtful that a tumor may become more malignant with each recurrence. The histologic structure of a recurrence is nearly always that of the original growth.[1, 2, 22]

d. *Postoperative Complications.*—Facial nerve paralysis is a frequent injury, but it is more common after removal of the malignant tumors, when the nerve is deliberately sacrificed. Other postoperative complications, such as salivary fistula and ankylosis of the jaw, are unusual.

TABLE IV

DAMAGE TO FACIAL NERVE BY SURGERY

(PARTIAL AND COMPLETE)

	TOTAL	BENIGN	MALIGNANT
Benedict and Meigs[2]	13.7%	7.5%	20.0%
Stein and Geschickter[22]		10.0%	
McFarland[13]	4.4%		
Ahlbom[1]	16.9%	11.0%	36.6%

3. *Treated by Irradiation Only.*—Benign mixed tumors are essentially ray resistant. Irradiation may shrink the mass to a smaller size, but a lump usually remains. Many respond only slightly, if at all. The size may be controlled and even an apparent cure obtained in individual cases (Quick and Johnson, quoted by Ahlbom). A single case was successfully treated by Ahlbom.[1]

4. *Treated by Surgery Combined With Irradiation.*—Ahlbom strongly advocates preoperative x-ray therapy and the postoperative application of radium element in the wound. His statistics indicate a much lower rate of recurrence than by surgery alone for benign neoplasms, with no deaths from the tumor.

TABLE V (FROM AHLBOM[1])

BENIGN TUMORS—TREATED BY COMBINED SURGERY AND IRRADIATION

FOLLOW-UP PERIOD	NO. OF CASES	RECURRENCE	
		NO.	%
2 yr.	88	2	2%
3 yr.	71	2	3%
5 yr.	40	1	2½%
8 yr.	24	2	8%
11 yr.	15	1	7%

B. *Semimalignant Tumors* (Semimalignant group has been used only by Ahlbom, and the data below are taken from his monograph).

1. *Untreated.*—Ahlbom believes that more active malignancy may develop, the semimalignant tumors becoming more definitely malignant. Recurrences were histologically clearly malignant.
2. *Treated by Surgery Only.*—None.
3. *Treated by Radiotherapy Only.*—Five cases were so treated because of radiosensitivity and disappeared after irradiation. A single case recurred, after fourteen years, and the recurrence was eradicated by further irradiation.
4. *Treated by Surgery Combined With Radiotherapy.*—The recurrence rate was double that of the benign group and three patients died from the tumor. Three recurrences were histologically more malignant than the original semimalignant neoplasm.

C. *Malignant Tumors*

1. *Untreated tumors* exhibit a relatively low grade of clinical malignancy compared with other carcinomas and sarcomas. Grow rather slowly, with the rate of growth accelerated in the terminal stage. Inevitably fatal, death resulting from invasion of the neck and head after a horrible, extremely painful terminal course. Metastases occur late.
2. *Treated by Surgery.*
   a. *Life Expectancy.*—Average less than 2 years after operation.[1, 2, 13] Operative trauma appears to accelerate growth.[13] Recurrence and death from the tumor are almost certain. Facial nerve paralysis usually follows operation and there is a definite operative mortality.
3. *Treated by Radiotherapy Only.*—Radiation therapy has been considered by many to be of little benefit.[2, 14, 21] Ahlbom[1] reports 32 per cent of 62 cases free from symptoms and signs after 2 years, and 23 per cent of 39 cases free from symptoms and signs after 5 years, along with 2 cases well after 11 years.
4. *Treated by Surgery Combined With Radiotherapy.*—Benedict and Meigs[2] found that irradiation after operation prolonged life for several years but did not cure the disease. In the Radiumhemmet series,[1] of 62 cases, 58 per cent were free from signs and symptoms after 2 years; and 40 per cent of 35 cases after 5 years; 6 survived for 8 years, and 2 for 11 years, free from symptoms.

SUMMARY

From the assembled literature, a number of pertinent facts are outstanding:

1. Although many salivary neoplasms pursue a benign course, all such tumors must be considered potentially malignant.

2. The malignancy is of variable degree and is often of low grade, a "relative" malignancy.

3. Evaluation of published prognostic data is impeded by lack of uniformity in pathologic nomenclature and classification, particularly in regard to malignancy.

4. The microscopic determination of malignancy is difficult and frequently inconclusive. The criteria of individual pathologists differ.

5. Preliminary biopsy is condemned and a clinical preoperative diagnosis is preferable, particularly since pathologic classifications have proved unsatisfactory as a guide for treatment.

6. Fixation of the tumor to the skin or deeper structures, with lack of mobility, stands out as the most reliable clinical sign of malignancy.

7. A therapeutic trial with irradiation appears to be a valuable guide in diagnosis and treatment.

8. Current opinion favors surgery combined with radiotherapy in most cases, although treatment must be individualized.

9. Treatment of the more benign tumors by surgery has given fairly good results, although recurrences and facial nerve injury are quite frequent. Better results have been obtained at the Radiumhemmet by combined surgery and irradiation.

10. Treatment of malignant tumors by surgery alone is unsatisfactory. Most patients have died within two years after operation, contrasting with the average preoperative duration of seven years. Radiation alone or radiation combined with surgery prolongs life and occasionally gives a brilliant result.

11. McFarland's suggestion that many patients are better left untreated should serve as a check on useless or harmful surgery.

12. There is need for a satisfactory classification based on clinical findings and follow-up results as an index of operability.

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TUMORS OF THE SALIVARY GLANDS*

II. A Study of 48 Cases, With the Presentation of a New Clinical Classification

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THE PRESENT study presents a series of cases of tumors of the salivary glands for correlation with data from the literature. A simple practical classification based entirely on clinical findings is offered as a basis for treatment and prognosis.

Forty-eight tumors of the parotid, submaxillary, and sublingual glands from the files of the University of Virginia Hospital have been reviewed and studied. The microscopic structure of four cases was that of epidermoid carcinoma; of one, pigmented melanoma; and of another, chronic inflammation of the submaxillary gland. These cases were included since they had been diagnosed and treated as tumors of the salivary glands. The records have been analyzed and the patients brought back for examination when possible. Follow-up data were obtained by letter or from the hospital records in many instances. Complete information as to the postoperative course and survival was obtained in forty cases. An attempt to trace six other patients, who failed to answer final inquiries, was made by investigation at the Bureau of Vital Statistics of the State of Virginia, and no death certificate was recorded in any such instance. Since these six individuals lived in this state, it may be assumed that in all probability they are still living. All attempts to trace two patients failed.

Microscopic slides were reviewed by serial number and a "revised pathological diagnosis" was reached without reference to the clinical course. The type of epithelium and other microscopic points of interest were tabulated in an attempt to evaluate the various microscopic criteria of malignancy which have been suggested in the literature. Pathologic and clinical data are assembled in Table I.

PATHOLOGY

From the histologic structure alone the tumors were listed according to the revised pathological diagnosis (Table II).

The simplest possible system of pathologic classification was selected. The placement of individual cases in this classification was based on pathologic criteria roughly similar to those of Ahlbom.[1] However, if the

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TABLE I

BENIGN MIXED TUMORS

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOUCK)*	ENCAPSULATION†	TREATMENT‡	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA							ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA§	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS	
68515	33	1 yr.	II	3 inv.	S	15 yr.	Well 8 yr. to date	2	3	Glandular, adenocystic areas	1-2	0	4	0	0	Mixed tumor	Benign mixed tumor
55028	23	6 mo.	I	4	S	15 yr.	Unknown	3	2	Glandular, adenocystic, cylindromatous	1-2	0	4	0	0	Mixed tumor	Benign mixed tumor
117614	37	0	I	4	S	3 yr.	Well 1 yr. to date	3	1	Glandular, slight adenoid tendency	3	0	0	0	0	Mixed tumor	Benign mixed tumor
117331	27	1 yr.	I	2	S	3 yr.	Well 1 yr. to date	1	4	Glandular	2	0	0	0	0	Mixed tumor	Benign mixed tumor
87356	33	4 yr.	I	3	S	30 yr.	Well 2 yr. to date	2	3	Glandular, slight adenoid tendency	2	0	0	0	0	Mixed tumor	Benign mixed tumor

*See latter part of paper.

†Encapsulation graded *1*, *2*, *3*, and *4* to indicate thickness and completeness of encapsulation. *Inv.* indicates invasion of the capsule by tumor growth.

‡*S*, Surgical; *R*, radiotherapy; *S* & *R*, surgery combined with radiotherapy.

§Anaplasia or dedifferentiation graded *1*, *2*, *3*, and *4* after the method of Broders. Numbers *1*, *2*, *3*, and *4* are used in the other columns to indicate quantity or degree.

82433	17	0	I	?	S	40 yr.	Well 6 yr. to date	2	2	Glandular, cylindroma	1	0	0	0	0	Mixed tumor	Benign mixed tumor (cylindroma)
50234	19	0	III	3	S	6 yr.	Well 11 yr. to date	0	4	None present, pure myxofibroma	0	0	0	0	0	Fibroma	Fibroma (sublingual gland)
59789	11	0	I	2 inv.	S	8 yr.	Well 10 yr. to date	3	2	Glandular, adenocystic	2	0	3	0	0	Mixed tumor	Benign mixed tumor
58944	38	0	III	?	S	5 yr.	Well 10 yr. to date	1	4	Glandular, adenocystic	1	0	4	0	0	Mixed tumor	Benign mixed tumor
64375	19	0	I	?	S	10 mo.	Well 9 yr. to date	2	3	Glandular, solid, and adenocystic	2	0	4	0	0	Mixed tumor	Benign mixed tumor
94391	59	6 mo.	III	3 inv.	S	1 yr.	Well 4 yr.; died, pneumonia	2	3	Glandular, adenoid	1	0	2	0	0	Mixed tumor	Benign mixed tumor
121803	9	0	I	1 inv.	S	40 yr.	Well 7 mo to date	3	1	Glandular, mostly solid, scanty adenoid	2	1	0	Areolar tissue around blood vessels	0	Mixed tumor	Benign mixed tumor
80856	24	0	I	2	S	3 yr.	?	1	4	Glandular, slight adenoid	1-2	0	0	0	0	Mixed tumor	Benign mixed tumor
115870	31	0	II	4 inv.	S	5 yr.	Well 16 mo. to date	3	2	Glandular, solid masses	2-3	0	2	0	0	Mixed tumor	Benign mixed tumor

TABLE I—CONT'D
BENIGN MIXED TUMORS

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOUCK)*	ENCAPSULATION†	TREATMENT‡	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA								ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA§	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS		
51301	31	0	III	?	S	6 yr.	Well 11 yr. to date	2	3	Glandular cell masses	3	0	0	0	0	Myxoadenoma	Benign mixed tumor
32136	13	0	I	?	S	1 yr.	No death certificate 15 yr.	2	3	Glandular cell masses	2-3	0	?	0	0	Mixed tumor	Benign mixed tumor
30129	35	2 wk.	II	3 inv.	S & R	10 yr.	Well 10 yr. to date	3	2	Glandular, adenocystic, basal cell character	1-2	0	0	0	0	Basal cell carcinoma	Benign mixed tumor (basal cell type)
37533	25	0	I	?	S	10 yr.	Well 14 yr. to date	2	3	Glandular	3	0	0	0	0	Mixed tumor	Benign mixed tumor
105932	29	0	II	4 inv.	S	30 yr.	Died 2 yr., pneumonia	2	3	Glandular masses, slight adenoid tendency	1-2	0	2	0	0	Mixed tumor	Benign mixed tumor
94851	20	0	II	2	S & R	3 yr.	No death certificate, 4 yr.	2	2	Glandular, adenocystic, and masses, pearls	1-2	0	2	0	0	Mixed tumor	Benign mixed tumor

84263	41	0	I	?	S	3 yr.	Well 4 yr. to date	3	2	Glandular, mostly solid masses	2-3	0	0	0	0	Myxocarcinoma	Benign mixed tumor
107450	48	3 yr.	IV	3	S	12 yr.	Well 2 yr. to date									Mixed tumor	Benign mixed tumor
26797	22	2 mo.	I	3	S	4 yr.	Well 17 yr. to date		No slide—Clinical diagnosis								Benign mixed tumor
86363	51	0	III	?	None	15 yr.	Good health 3 yr. after diagnosis		No slide—Clinical diagnosis								Benign mixed tumor (clinical)
48543	14	0	III		S	4 wk.	Well 17 yr. to date		Not a tumor								Chronic inflammation submaxillary gland
							MALIGNANT MIXED TUMORS										
96322	55	0	I	3 inv.	S & R	1 yr.	Died 4 yr. postoperatively of "heart trouble"	2	3	Glandular solid masses	3	0	0	Parotid gland tissue inv.	0	Adenocarcinoma, parotid	Semimalignant mixed tumor
94685	61	0	I	3 inv.	S	9 mo.	Well 4 yr. to date	4	1	Glandular solid masses	3	1	0	0	0	Adenocarcinoma	Semimalignant mixed tumor
58313	44	0	I	3	S	6 yr.	Died 4 yr., psychosis	2	3	Basal and squamous type of epidermoid epithelial pearls	2	0	0	0	0	Myxoadamantinoma	Semimalignant mixed tumor

TABLE I—CONT'D

MALIGNANT MIXED TUMORS

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOUCK)*	ENCAPSULATION†	TREATMENT‡	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA								ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA§	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS		
86999	16	0	IV	?	S & R	11 yr.	Died 5 yr. postoperatively of recurrence	2	3	Glandular, adenocystic	2	0	0	Recurrence very inv.	0	Adenocarcinoma	Malignant mixed tumor
84680	68	8 mo.	I	2 inv.	S & R	2 yr.	Died 2 yr. "heart failure"	4	1	Glandular, chiefly solid masses	2-3	0	0	0	?	Fibromyxocarcinoma	Semimalignant mixed tumor
79070	25	0	III	?	S & R	15 yr.	Well 6 yr. to date	4	1	Glandular solid masses	3	1	0	0	0	Myxocarcinoma	Malignant mixed tumor
101125	15	6 mo.	IV	3 inv.	S & R	4 yr.	4 yr. to date? recurrence	3	2	Glandular (adenoid), epidermoid carcinoma overgrowth	3	2	0	Salivary gland tissue inv.	0	Mixed tumor with epidermoid carcinoma (branchiogenic)	Mixed tumor malignant (epidermoid)

99773	15	0	III	2	S & R	2 yr.	Well 4 yr. to date; recurred 1 yr.	4	2	Glandular adenoid cystic	2	0	0	0	0	Adeno-carcinoma, parotid	Malignant mixed tumor
42848	37	0	III	0	S & R	6 yr.	Died from tumor 14 mo. post-operatively	3	2	Glandular solid masses	3	1	0	Connective tissue inv.	0	Mixed tumor, malignant	Malignant mixed tumor
41905	24	2 mo.	IV	3	S & R	20 yr.	Well 12 yr. to date	4	1	Glandular type almost absent	4	3	0	Along blood vessels and nerves	0	Mixed tumor, malignant	Mixed tumor semi-malignant
11582	34	6 yr.	IV	?	S	28 yr.	Died 4 mo. from tumor			Clinical diagnosis				Recurrence inv.	0	Mixed tumor or sarcoma (clinical)	Mixed tumor malignant (clinical)
54591	28	0	IV	?	R	15 yr.	Died 1 yr. from tumor			Clinical diagnosis				Recurrence inv.	0	Mixed tumor, malignant (clinical)	Mixed tumor malignant (clinical)
ADENOCARCINOMA, SALIVARY GLAND																	
66233	47	?	IV	0	S & R	1 yr.	Died 4 days post-operatively	4	1	Glandular solid masses	4	3	0	Salivary gland	0	Carcinoma, parotid	Adeno-carcinoma, parotid

TABLE I—CONT'D
ADENOCARCINOMA, SALIVARY GLAND

HISTORY NUMBER	AGE NOTICED IN YEARS	ACCELERATION OF GROWTH	CLINICAL GROUP (HOUCK)*	ENCAPSULATION†	TREATMENT‡	DURATION BEFORE TREATMENT	SURVIVAL FOLLOW-UP RESULTS	HISTOLOGICAL CRITERIA							ORIGINAL MICROSCOPIC DIAGNOSIS	REVISED MICROSCOPIC DIAGNOSIS
								CELLULARITY	QUANTITY OF STROMA	TYPES OF EPITHELIUM	ANAPLASIA§	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	INVASION OF NORMAL TISSUES	METASTASIS	
36085	62	1 mo.	III	0	S & R	6 mo.	Died 3 yr. from tumor	4	1	Glandular solid masses	4	3	0	Lymph nodes	+	Adenocarcinoma, parotid	Adenocarcinoma, parotid
52712	45	0	IV	2 inv.	S & R	3 yr.	Died 19 mo. from tumor	3	2	Glandular solid masses	3	2	0	Salivary gland	0	Adenocarcinoma, parotid	Adenocarcinoma, parotid
98591	56	0	IV	2 inv.	Biopsy and x-ray	7 mo.	Well 4 yr. to date	4	1	Glandular, adenoid tendency	2	0	0	0	0	Adenocarcinoma, parotid	Adenocarcinoma, parotid
50533	40	1 yr.	IV	3 inv.	S & R	15 yr.	Died 6 yr. postoperatively of tumor	1	3	Glandular, adenoid	2-3	0	0	0	0	Adenocarcinoma, submaxillary gland	Adenocarcinoma

TABLE I—CONT'D

OTHER MALIGNANCIES

101038	42	0	III	2	S	1 yr.	Well 3½ yr. to date	4	1	Epithelial cells pigmented	3	1	0	Lymph nodes	+	Melanoma	Pigmented melanoma
84244	65	0	III	3 inv.	S	1 yr.	Died 2 yr. post-operatively of tumor	4	1	Epidermoid	4	4	0	Lymph nodes	+	Adenocarcinoma, submaxillary gland	Metastatic epidermoid carcinoma
44694	22	0	III	0	S & R	2 yr.	No death certificate	4	2	Epidermoid characteristics	3	2	0	Salivary gland	0	Carcinoma, parotid	Carcinoma, epidermoid?
65011	78	0	III	0	S & R	10 mo.	Died 9 yr. post-operatively of tumor of pharynx	4	1	Epidermoid pearls	2	2	0	0	0	Adenocarcinoma	Epidermoid carcinoma
109874	66	0	II	1	S	8 yr.	Recurred; well 2 yr. to date	4	1	Epidermoid in wall of cyst	3	2	0	0	0	Branchiogenic carcinoma	Epidermoid carcinoma in cyst

TABLE II

TUMOR TYPE	NO. OF CASES	
Mixed tumor, benign	24	
Fibromyxoma, sublingual gland	1	
Chronic inflammation, submaxillary gland	1	
Total benign	26	(54.1%)
Mixed tumor, malignant	12	
Pigmented melanoma	1	
Adenocarcinoma, salivary gland	5	
Epidermoid carcinoma	4	
Total malignant	22	(45.9%)

concept of "relative malignancy" is kept in mind, a semimalignant group as used by Ahlbom should be unnecessary. The terms mixed tumor, benign, and malignant are in common usage. A better terminology for the so-called mixed tumors would be relatively benign and relatively malignant, in view of the potential malignancy of the entire group.

If the malignant and benign mixed tumors are grouped together, the result is 36 mixed tumors, or 75 per cent of the total. If the 6 cases which apparently were not primary salivary gland neoplasms are discarded and the fibromyxoma included, the total is 42 cases with 37 mixed tumors (89 per cent) predominating.

The validity of the revised pathological diagnosis was checked by reference to follow-up statistics (Table IV). Postoperative recurrence was noted in 4 per cent of benign mixed tumors, in 50 per cent of malignant mixed tumors, and in 60 per cent of adenocarcinomas. In no case was there a fatal outcome in the benign group, although in 33 per cent of malignant mixed tumors and in 80 per cent of adenocarcinomas death has resulted from the neoplasm.

TABLE III

HISTOLOGIC CRITERIA*

REVISED HISTOLOGIC DIAGNOSIS	CELLULARITY†	QUANTITY OF STROMA†	ANAPLASIA†	NUCLEAR CHANGES	CARTILAGINOUS TISSUE	ADENOCYSTIC OR CYLINDROMATOUS AREAS	ENCAPSULATION†	CAPSULE INVADED	NORMAL TISSUE INVADED
Benign mixed tumor	2.2	2.8	1.9	4.3%	43%	71%	3	28%	4%
Malignant mixed tumor	3.2	1.9	2.8	50 %	0	33%	2.4	33%	41%
Adenocarcinoma	3.3	1.6	3.2	75 %	0	0	1.4	100%	60%
Other malignancies	4	1.2	3	100 %	0	0	1.2	60%	60%

*Averages estimated from Table I.

†Relative figures based on a *1, 2, 3, 4* grading.

TABLE IV

AVERAGES OF CLINICAL DATA FROM TABLE I

REVISED HISTOLOGIC DIAGNOSIS	NO. OF CASES	AVERAGE AGE FIRST NOTICED	AVERAGE PREOPERATIVE DURATION	FACIAL NERVE INJURY OR OTHER OPERATIVE COMPLICATIONS	RECURRENCE	DEATH FROM TUMOR	RADIOTHERAPY USED
Benign mixed tumor	25	28 yr.	10.5 yr.	20%†	4%‡	0	8%
Malignant mixed tumor	12	35 yr.	9.2 yr.	42%	50%	33%	75%
Adenocarcinoma	5	50 yr.	4 yr.*	60%	60%	80%	100%

*If one exceptional case of 15 years' duration is included, this average would be 13 years.

†Three cases with facial nerve injury were in Houck's Clinical Group III, and two in Clinical Group II.

‡A single patient, on return examination, showed a possible but questionable recurrence in the scar; refused treatment.

In Part I[3] it was stated that, in the reviewed literature, the distinction between malignant mixed tumors and pure carcinomas was frequently not clearly defined. The distinction between benign and malignant mixed tumors is also not always defined. The comparative data in Tables II and III, along with Ahlbom's statistics,[1] apparently justify such distinction.

Nevertheless, the fact that all mixed tumors are probably potentially malignant must not be disregarded. In benign mixed tumors in this series, invasion of the capsule by the epithelial element was noted in 28 per cent (Table III) and possibly would have been found in more if the entire specimen had been examined microscopically. This invasive tendency is perhaps of importance in the pathogenesis and clinical behavior of these tumors. There is characteristically a well-defined capsule. There is also a tendency toward reencapsulation of cells which break through the original capsule.[1] Mixed tumors of long standing are of nodular structure, each nodule surrounded by a separate distinct capsule. This nodular structure most probably develops by invasion of the capsule of the original tumor nodule by growing cells, which, in turn, become encapsulated and form daughter nodules. It seems possible that the expression of potential malignancy becomes evident when the balance between the invasive tendency of the tumor and the encapsulating property of fibrous tissue of the individual host is broken down, with concurrent acceleration of growth. Acceleration of growth following operative trauma may similarly represent a breakdown of this biologic balance by damage to the protective capsule and fibrous tissue barriers. The protective capsule is less prominent in definitely malignant mixed tumors.

HISTOLOGIC CRITERIA OF MALIGNANCY

An attempt was made to evaluate the histologic criteria of malignancy which have been suggested in the literature. The averaged results are summarized in Table III. Although most of these criteria, as previously stated, must be considered to be of relative importance, if all of them are considered together in a given case, they appear to have definite value in determining the malignancy of the given tumor.

As noted by Stein and Geschickter,[5] the character of the stroma, particularly the presence or absence of cartilage-like tissue, appears to be a more important criterion than the cellularity or the anaplasia of the epithelium. In Table III the type of epithelium, nuclear changes, and invasion of normal tissue stand out as significant criteria. Normal tissue was invaded in a single case of benign mixed tumor, where a few epithelial cells had penetrated the areolar tissue about a group of blood vessels (Case 121803).

CLINICAL FEATURES

Of the 48 cases studied, there were 25 males and 23 females. In 22 cases the tumor was on the right side of the neck and in 25 on the left side. This even distribution is in accord with published statistics.[1] Thirty-nine were in the region of the parotid; 8, of the submaxillary; and 1, of the sublingual gland. Thirty-three patients (70 per cent) were white and 15 (30 per cent), negroes. At the University Hospital 83.6 per cent of hospital patients are white and 16.4 per cent, colored. Stein and Geschickter[5] have provided the only other statistics on distribution between the white and negro races and assumed the frequency to be greater among whites. Comparison is given in the table below:

	SALIVARY TUMORS		HOSPITAL ADMISSIONS	
	WHITES	NEGROES	WHITES	NEGROES
Stein & Geschickter	80.1%	19.9%	Not	given
Houck	70.0%	30.0%	83.6%	16.4%

Although the present series is small, when referred to the distribution of whites and negroes in hospital admissions, the distribution of salivary tumors among the two races would appear to be fairly even.

CLINICAL CRITERIA OF MALIGNANCY

1. *Subjective symptoms* were prominent in all of the adenocarcinoma cases, with spontaneous facial paralysis in one. Mild pressure symptoms or mild pain occurred in less than one-half of benign and malignant mixed tumors.

2. *Age of Patient.*—Tumor was first noticed at a somewhat greater average age in the malignant groups (Table IV).

3. *Duration of Tumor.*—Although there was little difference in the average preoperative duration of benign and malignant mixed tumors, the duration was much shorter for adenocarcinomas (Table IV). This fact confirms McFarland's[4] observation that, if a tumor brings the patient to operation within one year of onset with the microscopic picture of carcinoma, the prognosis is ominous.

4. *Acceleration of growth* was about as common in benign as in malignant tumors. In benign tumors this phenomenon possibly represents the formation of new daughter nodules.

5. *Mobility.*—Fixation of the tumor appears to be much more common in malignant tumors and a fairly reliable criterion of malignancy:

NO. OF CASES	FIXED	MOVABLE
Benign	6	20
Malignant	17	5

These figures are in accord with Ahlbom's findings.[1]

6. *Metastases.*—Lymph node metastasis was found in a single case of adenocarcinoma and a questionable lymph node involvement in a single case of malignant mixed tumor.

MALIGNANT CHANGE IN MIXED TUMORS

The average preoperative duration of benign and malignant mixed tumors is about the same in this series of cases (Table IV) and in statistics published elsewhere.[1, 3] Over 50 per cent of the malignant mixed tumors in this series had been noticed from six to twenty-eight years before treatment. Such tumors were probably potentially malignant from the start.

There was no microscopic evidence of a malignant change except in one case (No. 101125), in which an epidermoid carcinoma was present in a tumor which otherwise showed the structure of the more benign mixed tumors and a preoperative duration of six years. Acceleration of growth had been noted for six months.

TREATMENT

Operative excision, partial or complete, was performed in all but three cases. In sixteen cases surgery was supplemented by radiation therapy, in one form or another. Two cases were considered inoperable and were treated by radiation therapy only. In both of these incision was made into the tumor, in one for biopsy and in the other for insertion of radium needles. A single case, in which there was a slow-growing, apparently benign tumor, was not treated at all because of old age and multiple infirmities.

Radiation therapy was applied in the form of high voltage x-ray, both preoperative and postoperative, radium element placed in the

wound, interstitial radium needles, and radium packs. The methods and dosage were not standardized and were different in nearly every case. In many cases the dosage was rather small in comparison with the more recent radiologic techniques.

RESULTS OF TREATMENT

The results of treatment of salivary tumors in this series parallel fairly closely previously published data with the exception that the recurrence rate was much lower in benign tumors in this series. The results of treatment of malignant tumors in this series are inferior to Ahlbom's results, possibly due to less efficient use of irradiation.

Benign Tumors.—Of 25 cases treated by surgical excision, no patient has died from the tumor and a single possible recurrence is noted. Partial or complete facial nerve paralysis followed operation in 5 cases (20 per cent). Eleven cases were followed for eight years, and 9 cases for ten (Tables I and IV). Supplemental irradiation was used in small doses in only 2 cases, with no significant effect. Surgery in benign mixed tumors in this series has apparently been quite effective in eradicating the tumor, with a very slight risk of recurrence. Nevertheless, a 20 per cent incidence of facial nerve paralysis raises a doubt as to the desirability of surgical treatment. Of 5 cases with facial nerve injury, 3 were small and fixed, and 2, large and mobile. If the 6 benign cases exhibiting fixation are eliminated, the percentage of nerve injury would be 10.5 per cent. No nerve injury occurred in 14 cases, where the tumor was small and mobile, and surgery was effective for the benign tumors in this group.

Malignant Mixed Tumors.—

1. Treated by surgery only, 3 cases: 1 died in 4 months from the tumor; 1 died in 6 years of "psychosis"; and 1 is living and well after 4 years.

2. Treated by radium needles only, 1 patient who died in one year from the tumor; salivary fistula and ankylosis of the jaw followed treatment.

3. Treatment, surgery combined with irradiation, 8 cases: recurrence in 4 (50 per cent); death from recurrence in 2 (25 per cent); death from "heart failure," 2 within four years; living and well, 2, 1 for thirteen years and 1 for six years.

Of the total malignant mixed tumors, death from the tumor followed treatment in 33 per cent, the tumor recurred in 50 per cent, and facial nerve injury or other complication was observed in 42 per cent. The malignancy of individual tumors varies widely. Radiation therapy appears to be beneficial in individual cases.

Adenocarcinomas.—Four of the 5 cases were treated by surgery combined with irradiation. One patient died of embolus four days after

operation, and the other 3 from the tumor after nineteen months, three years, and six years, respectively; mortality was 100 per cent; recurrence, 80 per cent; facial nerve injury, 75 per cent.

A single case was considered inoperable. A biopsy was performed, followed by high voltage roentgen ray therapy. The mass disappeared and the patient has been well four years to date.

In cases treated by surgery combined with irradiation, treatment was of little or no benefit, and possibly was harmful. A single case was effectively treated by irradiation alone.

CLINICAL CLASSIFICATION OF MALIGNANCY AND OPERABILITY

McFarland's[4] tabulation of salivary tumors as to size and recurrence represents the only previous effort toward formulating a classification based on clinical examination as an index of operability. Ahlbom's principle of therapeutic trial with external irradiation[1] is of aid in determining operability and malignancy, benign tumors being generally more ray resistant.

Tabulation of the tumors in this series after McFarland's method (Table V) confirms his finding that recurrence is frequent when the tumor is removed while small. Facial nerve injury, which was not considered in McFarland's study, was frequent in all groups.

TABLE V

TABULATION OF TUMORS IN THE PRESENT STUDY BY MCFARLAND'S CLASSIFICATION[4]

SIZE	NO. OF TUMORS	FACIAL NERVE PARALYSIS AFTER TREATMENT		RECURRENCE	
Smaller than a walnut	18	4	22%	3	17%
Walnut to lemon size	24	5	21%	8	33%
Larger than a lemon	8	3	37%	2	25%

In Part I[3] the need for a satisfactory clinical classification was expressed. Fixation of the tumor was singled out as the most reliable clinical criterion of malignancy. The treatment of malignant tumors by surgery was found to be generally ineffective, at times doing more harm than good. With these facts in mind, all tumors in this study were grouped according to both size and mobility as follows:

Group I Tumors freely movable; size 4 cm. or less in diameter
Group II Tumors freely movable; size larger than 4 cm.
Group III Tumors partly or completely fixed; size 4 cm. or less in diameter
Group IV Tumors partly or completely fixed; size larger than 4 cm. in diameter

The application of this combined method of clinical classification to the present material has resulted in a number of interesting correlations (Table VI).

TABLE VI

CLINICAL GROUP (HOUCK)	TOTAL	HISTOLOGIC DIAGNOSIS					AVERAGE DURATION	INCOMPLETE EXCISION	PART OR ALL OF SALIVARY GLAND REMOVED	FACIAL NERVE INJURY		OTHER COMPLICATIONS	RECURRENCE		DEATH FROM TUMOR
		MIXED TUMOR BENIGN	MIXED TUMOR MALIGNANT	CARCINOMA OR OTHER MALIGNANCY	TOTAL BENIGN	TOTAL MALIGNANT									
		NO.	NO.	NO.	%	%	YRS.	NO.	NO.	NO.	%	NO.	NO.	%	NO.
I. Freely movable; 4 cm. or less in diameter	18	14	4*	0	78	22	10.4	0	1	0	0	0	1	6	0
II. Freely movable; larger than 4 cm. in diameter	6	5	0	1	83	17	11.8	0	1	2	33	0	1	17	0
III. Partly or completely fixed; 4 cm. or less in diameter	13	5	3	5	38	62	3.6	1	4	7	54	0	5	38	4
IV. Partly or completely fixed; larger than 4 cm. in diameter	10	1	5	4	10	90	10.9	6	2	3	33	3 (Fatal 2)	6	60	6
Total movable tumors	24	19	4	1	83	17	11.1	0	2	2	11	0	2	11	0
Total fixed tumors	23	6	8	9	26	74	7.2	7	6	10	43	3	11	49	10

*All four of the malignant mixed tumors in Clinical Group I were diagnosed as semimalignant in Table I. There are no tumors of sharply defined histologic malignancy in Clinical Group I. The semimalignant mixed tumors were grouped with malignant mixed tumors since the series is small.

1. Eighty-three per cent of the movable tumors were diagnosed histologically benign.

2. Seventy-four per cent of the fixed tumors were diagnosed histologically malignant.

3. In Group I (small, movable) there was a single possible recurrence (6 per cent). There were no facial nerve injuries and no deaths from the tumor.

4. In Group II (large, movable) there was 1 recurrence (17 per cent), 2 facial nerve injuries (33 per cent), and no deaths from the tumor.

5. In Group III (small, fixed) 62 per cent were microscopically malignant; recurrence occurred in 38 per cent; and nearly one-third of the total have died from the tumor. The percentage of facial nerve injury (54 per cent) is the highest of any group.

6. In Group IV (large, fixed) 90 per cent were microscopically malignant; recurrence occurred in 60 per cent; and 60 per cent have died from the tumor. A high rate of facial nerve injury was sustained (33 per cent). Other postoperative complications included 1 fatal pulmonary embolus, 1 hemiplegia, 2 salivary fistulas, and 1 ankylosis of the jaw.

This clinical classification, based on size and fixation, should be of distinct aid in treatment and prognosis, since: (1) An estimation of malignancy is provided. (2) Preliminary biopsy is avoided. (3) Inconclusive histology can be disregarded. (4) An index of operability is provided, based on the chances of recurrence and operative complications.

In consideration of McFarland's finding that tumors removed while small recurred more frequently, it is of interest to note the effect of the factor of fixation on such statistics. Reference to Table VI shows that, of the total of 47 tumors, 18 were small and mobile (Group I) and 13 small and fixed (Group III). A single possible recurrence was noted in Group I with no facial nerve injury, while in Group III recurrence occurred in 38 per cent and the facial nerve injury rate was 54 per cent. The factor of fixation in 40 per cent of the small tumors possibly accounts for McFarland's findings. When one considers that many of the deeper or fixed neoplasms produce pressure symptoms and probably bring the patient to the surgeon earlier, his findings are plausibly explained.

SUGGESTED PLAN OF TREATMENT

In determining the cases which are suitable for operation, the character of the tumor (benign or malignant), the chance of recurrence, the possibility of facial nerve paralysis, and the possibility of incomplete excision are obviously of importance in making the decision and should be carefully considered. The clinical classification (Table VI) appears to be of value in making the decision.

The impression received in the present study is that rapidly growing tumors are usually malignant and that results of treatment of malignant salivary tumors by operation only have been universally unsatisfactory. After growth of a salivary tumor has proceeded to a deforming size, surgical treatment is more difficult and complications and incomplete excision are more frequent. It would appear expedient, therefore, to remove a tumor while small, if the factor of fixation is not present.

As in the treatment of other tumors, treatment of salivary tumors must be individualized, probably to a greater extent than neoplastic diseases of other regions. In selecting cases for operation or irradiation, the clinical grouping (Table VI) is recommended in the hope of decreasing operative complications and the use of surgery where the chance of cure is remote.

Although the present series is small, the striking contrasts between the four clinical groups defined apparently justifies the following general outline of treatment:

Group I (Small and Freely Movable).—All cases should be treated by surgical excision, unless the patient is aged or debilitated and the tumor of long duration with slow rate of growth. A preoperative therapeutic test of high voltage x-ray therapy is optional. If, following surgical excision, tissue section indicates possible malignancy, postoperative irradiation is indicated, either by radium element in the wound or by deep x-ray therapy.

Group II (Large and Freely Movable).—Fractional x-ray therapy is advisable in an effort to decrease the size of the tumor and facilitate operation (Ahlbom). Depending upon the response to irradiation, operative excision should be considered and performed in most instances. The cosmetic deformity of the tumor should be compared with the chance of facial nerve paralysis, which is infrequent in this group. Postoperative irradiation is indicated if the tissue section shows possible malignancy and is optional in benign cases.

Group III (Small and Fixed).—A trial of external irradiation in fractional doses is the treatment indicated. Surgical excision seldom should be attempted (facial nerve injury, 54 per cent; recurrence, 38 per cent), even if there is no response to irradiation. If external irradiation is ineffective and the clinical impression strongly indicates malignancy, interstitial emanation implants may be indicated.

Group IV (Large and Fixed).—External irradiation in a course of fractional doses is the only logical treatment. Implants of emanation should be avoided. Surgery is usually contraindicated (facial nerve injury, 33 per cent; recurrence, 60 per cent).

A possible exception to the above generalizations must be noted. In view of the results obtained by Hybbinette by a special operative tech-

nique (described by Ahlbom[1]), surgery may prove to be of value in Clinical Groups III and IV after a preliminary therapeutic trial of high voltage roentgen therapy. The size of the tumor may be decreased by irradiation, and mobility and cleavage may be improved. Tumors which were inoperable by ordinary methods, Hybbinette removed successfully by intracapsular curettage followed by blunt dissection removal of the capsule. Recurrence rate was 4 per cent, and no facial nerve injuries were obtained.

Ahlbom[1] recommends that irradiation be used on all cases, benign or malignant, operable or inoperable. In view of the excellent results reported from his clinic, this recommendation should be given due consideration.

RADIATION METHODS

Radiologic methods are changing so rapidly that any definite statements concerning the proper technique for salivary tumors must be subject to frequent modification. The majority of radiologists at present tend to avoid the use of emanation implants, although in individual cases good results have been obtained in tumors superficially located, particularly in recurrences. Fractional doses of external irradiation, chiefly in the form of high voltage x-ray, are favored in treating most cases. There is some question as to the quantity or total dosage which will give the best results. In this regard the recent publication by Chamberlin and Young[2] questions the use of the method of Coutard in treating all cases of cancer. These writers believe that tumors which are highly ray resistant possibly may be best treated by smaller doses of radiation, repeated at intervals. Reduction of blood supply and sealing of the lymphatics are said to be the advantage of this plan of treatment, when the epithelium of the tumor is too resistant to be totally destroyed by massive doses. A similar method has been successfully used at the Radiumhemmet for resistant salivary tumors.[1]

It is true that most salivary tumors are ray resistant and that the protective fibrous capsule of these tumors is most important in impeding spread of the growth. It is also true that the fibrous and fascial structures of the neck are important in limiting spread of growth, since these tumors spread chiefly by direct local invasion. Realizing that extensive irradiation may damage fibrous tissue, the preservation of fibrous barriers should be considered in radiologic, as well as in surgical, treatment.

The methods used by Ahlbom[1] at the Radiumhemmet are in accord with these principles. Tumors are first given light doses to test the individual sensitivity to the rays; if a marked response is obtained, radiation is continued to the maximum of tissue tolerance. If the response to irradiation is slight, smaller doses are given, repeated at intervals of six weeks or longer. Ahlbom[1] and Stewart[6] highly recommend

the use of filtered radium capsules placed in the wound at operation. Ahlbom[1] particularly favors application of radium in the wound in benign tumors.

SUMMARY

1. A series of 48 cases of tumors of the parotid, submaxillary, and sublingual glands has been reviewed, particularly in relation to the histologic character, the treatment, and the results of treatment. The latter include recurrence, facial nerve injury, and, in 40 cases, a complete follow-up.

2. From the study of these cases, a clinical grouping has been developed as follows:

Group I Tumors freely movable; size 4 cm. or less in diameter

Group II Tumors freely movable; size larger than 4 cm.

Group III Tumors partly or completely fixed, size 4 cm. or less in diameter

Group IV Tumors partly or completely fixed; larger than 4 cm. in diameter

3. A general program for the treatment of cases in each of the four clinical groups is suggested.

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BATHING TRUNK NEVUS

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IN 1917 Heuer reported a case of extensive congenital hairy nevus of the bathing trunk type associated with hematoma of the back and spina bifida occulta. In the same paper he presented 26 cases of bathing trunk nevus collected from the literature* and discussed the features of resemblance between this affection and von Recklinghausen's disease. Heuer's own case was the first reported of bathing trunk nevus associated with spina bifida occulta and hematoma of the back, although a group of related cases with spina bifida and hypertrichosis lumbalis had been described.

It is the purpose of this paper to record 2 cases of bathing trunk nevus seen at the New York Hospital and to review 11 cases found in the literature since 1917. A summary by Reuben in 1928, in which 31 cases were reviewed, included 19 of those mentioned by Heuer and 12 others for which no references were given. The latter 12 are not presented in this report. The total number of cases of bathing trunk nevus reported to date is 40.

The essential physical phenomena of von Recklinghausen's disease are the presence of pigmentation of the skin, cutaneous tumors or fibromas, and tumors of the nerves or neurofibromas. The symptoms include painful cramps, vague disturbances of the sensorium, and progressive loss of intelligence. Of the 27 cases of bathing trunk nevus reported by Heuer, 22 had various forms of pigmentation, 9 had cutaneous tumors, and 1 had neurofibromas.

The additional cases of bathing trunk nevus found in the literature were reported by Voerner, Helle, Cleuet and Ingelbrans, Wise, Siemens and Waardenburg, Reuben, Wiedemann, Lightwood, Bona and Cardenas, Bjorneboe and Andrews. A brief account of these cases will be given first.

CASE 1.—(Voerner, 1905.) This is the report of a female, aged 30 years, who, on examination, showed numerous small skin tumors, some the color of the adjacent skin, others slightly bluish. These tumors were soft and, when depressed, sank into the tissues, only to resume their former shape when the pressure was released. There were several pedunculated tumors, one hanging from the

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*Heuer's cases reported from the literature were those of Walther, Alibert, Kostial, DeAmicis, Hebra, Scarenzio, Michaelson, Jablokoff and Klein, Hyde, Variot, Planner, Linke, Eichhoff, Moller, Joseph, Ornstein, Thienel, Rohring, Rossie, Reinhardt (2 cases), Rost, Bonn, Fasal, Fox and "author unknown."

shoulder halfway down the arm. There was a definite abnormality of the distribution of pigment. Many pigmented spots were present over the body, and, below the level of the umbilicus, these were confluent, forming an extensive pigmentation which reached from the fifth vertebra on the back and the umbilicus in the front down to the thighs. This region had the appearance of a bathing trunk.

CASE 2.—(Helle, 1922.) (Fig. 1.) This is the report of an infant, 10 months old, the third child of parents aged 31 and 33 years. The child was strong, healthy, and active. The skin over the anterior and posterior surfaces of the body in an area arching from the right shoulder to the left groin was dark brown in color. Some portions of this area were only lightly pigmented; others were covered with dark brown hairs, especially thick about the shoulder and measuring up to 10 cm. in length. Over the right nipple hung a broad fibrolipoma about the size of a child's fist; two others resembling potatoes were in the dorsal midline at the same level. On the blond head of the child were numerous irregularly scattered brown hairy nevi, "ranging in size from that of a pea to that of a five mark piece." Similar tumors were seen on both cheeks and on the right temple. The extremities down to the toes and fingertips were dotted with brown nevi of varying size. The unusual mottled appearance of the hair was changed to uniform blond by the use of peroxide. The nevi of the face were treated with carbon dioxide snow. The larger tumors were excised.

Fig. 1.—Case 2 (Helle's case). A 10-month-old infant with a large, hairy nevus almost completely covering the torso and extending down over the thighs. Note the tumor near the right nipple.

CASE 3.—(Cleuet and Ingelbrans, 1923.) This is the record of a small child with a voluminous tumor of the scrotum, many smaller tumors, and abnormal pigmentation of the skin present since birth. There was no family history of similar tumors. The child was the youngest of nine children, all normal births. The parents reported little change in the tumor except that the broad pedicle to which it was attached had become elongated and smaller in circumference, allowing the tumor to hang down to the knees. This pedicle was attached to the perineum in the region of the anus. The tumor was "waxy" in consistency with occasional areas of harder substance. It measured 9 cm. in vertical direction, 11 cm. transversely, and 9 cm. anteroposteriorly. The entire cutaneous surface was very furrowed and roughened. One portion, the size of a nut, seemed independent of

the rest of the tumor. Small tumors were palpable on the abdomen. Abnormal pigmentation extended over the abdomen and the thighs. A few tumors were present over the face and the scalp. No neuromas were palpable. The child's growth had been normal for his age. When the child was 9 months old, the tumor

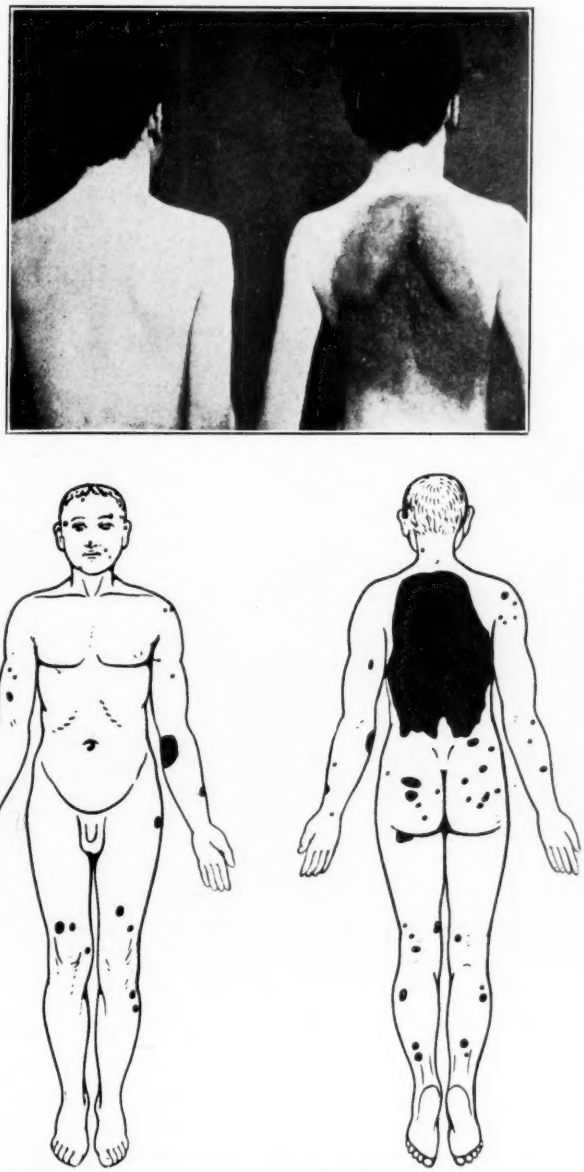

Fig. 2.—Case 5 (Siemens and Waardenburg). Identical male twins, 13 years of age. The one with the large hairy nevus over the back had sixty-two other hairy nevi over the body. The other twin had only one nevus, which was on the face and nonpigmented.

of the scrotum was removed. The tissues were not unusually vascular and the operation was performed without appreciable loss of blood. The testicles were found in their normal position. At 11 months of age, the child was in perfect health.

CASE 4.—(Wise, 1924.) This is the report of a 19-year-old girl who presented a bathing trunk type of nevus involving the body and thighs down to the knees and reaching up to the second dorsal spine. The lesion had been present since birth. At the back of the hips there was a mass the size of a cocoanut. On the right hip there was an extensive lipoma with smaller lipomas, the size of olives, lying underneath. On the left side there was a lipoma the size of an orange. Numerous pigmented nevi were situated on the face, trunk, and extremities. There were some keloids on the chest, the result of caustic applications. There were numerous pits on the face.

CASE 5.—(Siemens and Waardenburg, 1927.) (Fig. 2.) The authors report identical male twins examined at the age of 13 years. Both had fiery red hair, pale blue eyes, and light complexions. Both boys were freckled and were strikingly similar in appearance and in stature. Examination showed that one of them had a very large nevus covering the back. It extended from the lower cervical spine to the sacrum. It measured 22 cm. in breadth and 30 cm. in length. Over this region there was deep pigmentation and dense growth of blond hair. Sixty-two other nevi were scattered over the body. The other twin had only one nevus, the size of a pea, on his face. This was pedunculated, hard, hyperemic, and not pigmented.

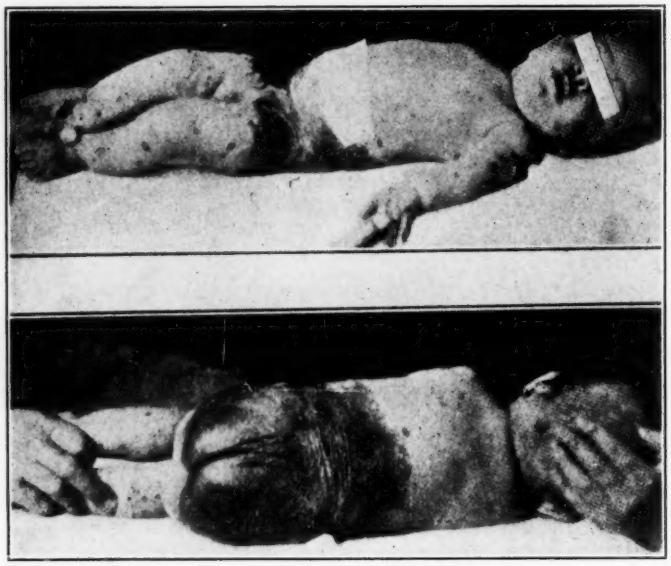

Fig. 3.—Case 6 (Reuben). Six-month-old infant with large pigmented nevus of bathing trunk type. Five hundred and eight pigmented spots were scattered over the body.

CASE 6.—(Reuben, 1928.) (Fig. 3.) This is the report of a male child, aged 6 months, whose parents noted that the child did not move the right leg. Physical examination revealed a large hairy pigmented nevus of the bathing trunk type. The general appearance of the child was normal; at 6 months of age, the child weighed 16 pounds. The anterior fontanel measured 1½ by 1½ inches; no teeth had erupted; the liver was large and its edge was felt two fingerbreadths below the costal margin; the spleen could not be felt. The genitals were not abnormally pigmented. Five hundred and eight pigmented spots were scattered over the body. These varied in size. They were not hair-bearing. The distribution of these spots was as follows: 106 on the head; 200 on the arms; 70 on the chest; 51 on the right leg; 80 on the left leg. There were two nonfluctuating masses present, one

over the ilium and the other over the left shoulder. The inguinal glands on both sides were definitely enlarged and hard. No other glandular enlargement was noted. The left knee showed signs of hydroarthrosis. X-ray showed that the bones were not diseased. One of the fluctuating masses had been aspirated by another physician who reported that it contained blood. There was no melanin in the urine.

CASE 7.—(Wiedeman, 1930.) This brief report describes a 15-year-old girl who had had, since birth, a hairy, pigmented nevus covering the entire abdomen and back, beginning at the fifth thoracic spine and extending down to the knees. It was dark brown in color. No other details were given in the report.

Fig. 4.—Case 8 (Lightwood). Large, hair-bearing nevus of the bathing trunk type with associated tumors (lipomas, neurofibromas). Infant, 8 months of age.

CASE 8.—(Lightwood, 1932.) (Fig. 4.) This is the report of a male infant, 8 months of age, apparently in good health, the only child of normal parents. The skin of the abdomen, back, and buttocks was deeply pigmented and in some areas was covered with fine hair. The condition had been noted at birth. The lesion was roughly symmetrical. There were several small pigmented moles on the scalp and legs. Under the pigmented skin of the back and abdomen were a number of tumors varying in size. The author reported some as firm, possibly neurofibromas; others as soft and lobulated, probably lipomas. No neurologic signs or symptoms were found. The tumors were not examined histologically. (In a discussion Dr. Parkes Weber said that he thought that the main feature of the case was a "pigmented nevus of bathing drawers distribution." It was his opinion that the hard subcutaneous nodules were neurofibromas of true von Recklinghausen's disease.)

CASE 9.—(Bona and Cardenas, 1934.) (Fig. 5.) The authors briefly record the history of a 27-year-old male with a bathing trunk nevus as shown in Fig. 5. The lesion was hyperkeratotic, pigmented, and hairy. There were raised tumors on the legs and forehead. The history was not remarkable. Photomicrographs of sections taken from some of the tumors led the authors to the opinion that the patient did not have true Recklinghausen's disease.

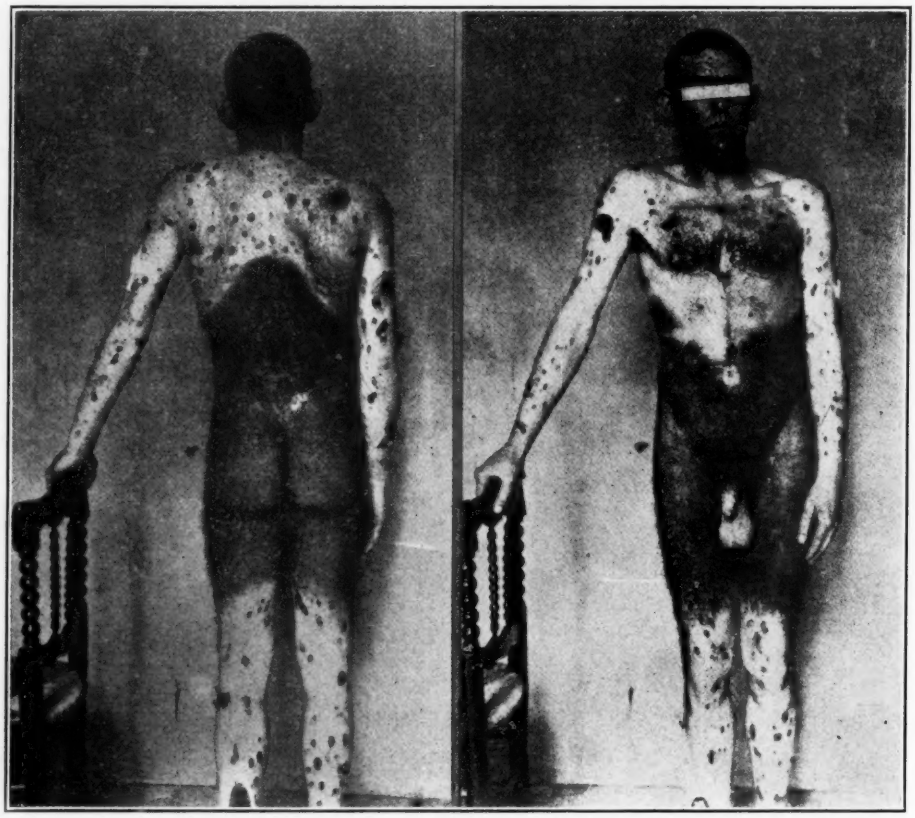

Fig. 5.—Case 9 (Bona and Cardenas). Bathing trunk type of hairy nevus occurring in a man 27 years of age in association with a great number of other hairy pigmented nevi.

CASE 10.—(Bjornboe, 1934.) (Fig. 6.) The author presents the case of a 37-year-old male with primary melanosarcoma of the brain, numerous pigmented nevi of the skin, bathing trunk nevus, and many neurofibromas of the subcutaneous nerves. The patient died after an illness of several months with symptoms of rapidly growing intracranial tumor. The complete autopsy diagnosis was as follows: melanosarcoma in the right hemisphere of the brain; countless pigmented nevi of the skin; hypostasis of the lower lobes of both lungs. The skin of the face and extremities showed innumerable brown spots "ranging in size from that of a pea to that of a penny," most of them quite hairy, only a few elevated above the surface. The trunk and thighs were covered with a furry coat of hair. There was elephantiasis of the skin over the buttocks.

CASE 11.—(Andrews, 1938.) (Fig. 7.) This is a brief report of a case of the bathing trunk type of nevus in an adult male, again associated with areas of pigmentation of the skin.

NEW YORK HOSPITAL CASES

CASE 1.—D.D.* (N. Y. H. History No. 198215) Fig. 8 shows a 2½-year-old female child, admitted to the New York Hospital on Jan. 20, 1915, with the chief complaint of a "lump between the legs." The patient's mother stated that at birth a small lump was noted on the right vulva and that this had gradually increased in size. There was no pain but the presence of the mass was annoying and its gradual increase in size caused concern. Past history and family history were not remarkable.

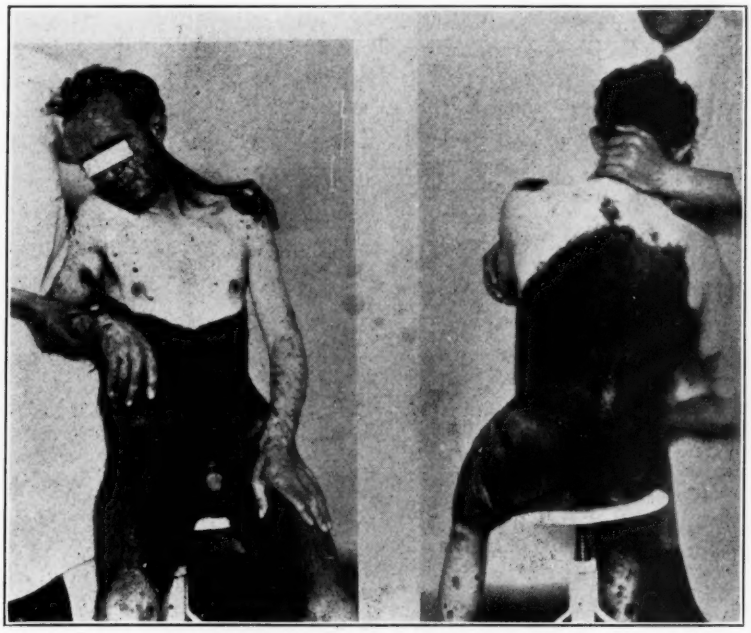

Fig. 6.—Case 10 (Bjornboe). A 37-year-old male with a large hairy nevus of the bathing trunk type, neurofibromas, other pigmented nevi, and melanosarcoma of the brain.

General examination showed that the child was well-developed and nourished, approximately normal in height and weight for her given age of 2½ years. She was normal in intelligence. Interest centered on the examination of the skin. At once evident was an extensive area of dark brown pigmentation, covering the lower thoracic region, the abdomen, buttocks, perineum, and right thigh. Roughly, its distribution corresponded to that of the well-known bathing trunk nevus. The skin over the pigmented areas was roughened, coarse, and covered with fine, long brown hairs. The skin elsewhere was of light color, numerous hair-bearing pigmented nevi being present over the neck, shoulders, and all extremities. These varied in size from minute areas of dark brown pigmentation to larger areas measuring 3 to 4 cm. in diameter. Other than the pigmented nevi, no tumors of the skin were found. There were no neuromas. Examination of the perineum showed that from the suprapubic region and the right labium majorum there hung a mass of soft tissues over which the skin was greatly thickened, corrugated, and scaly. The mass was freely movable but not compressible. It hung 5 cm. below the left labium. At the operation performed by Dr. Eugene Pool on Jan. 26, 1915, considerable hemorrhage was encountered in the excision of the mass. Pathologic report of examination of tissue removed was that of "elephantiasis vulvae." The patient made an uneventful convalescence.

*This case report included through the kindness of Dr. Eugene H. Pool.

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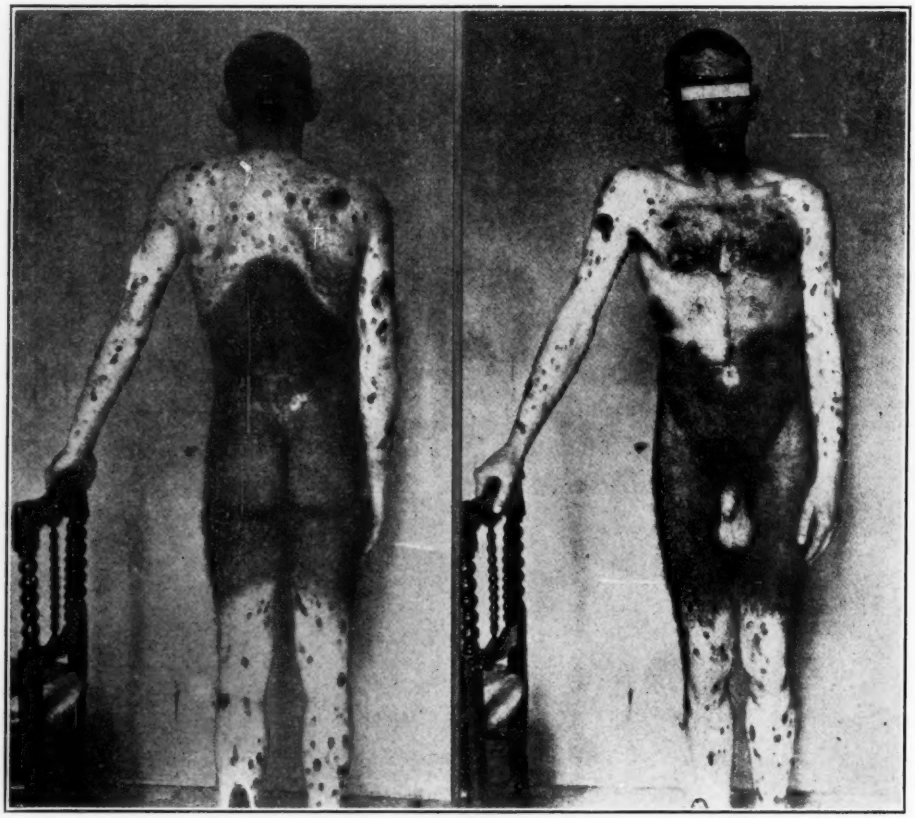

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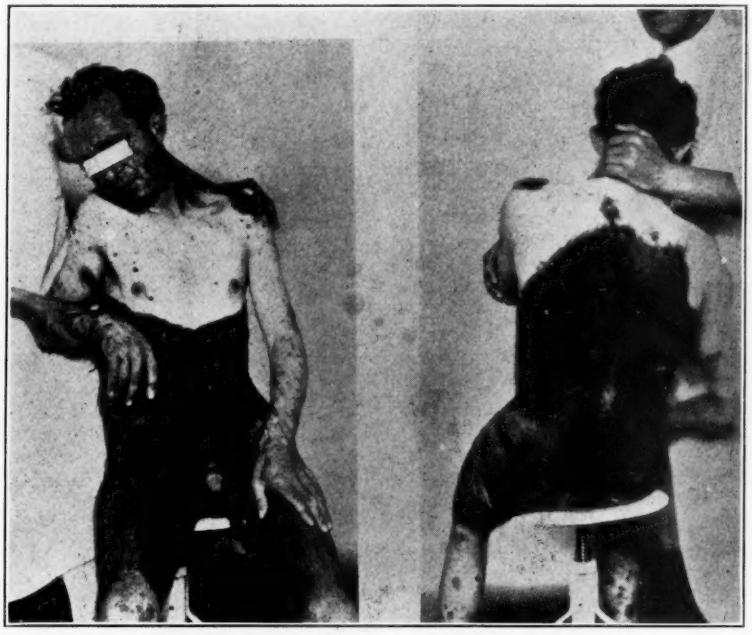

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This child's case was followed for five years. There was no recurrence of the mass, and her growth rate was normal. Photographs of this patient are shown in Fig. 8.

CASE 2.—N. C. (N. Y. H. History No. 123915) (Figs. 9 and 10). This is the report of double ovum, male twins, one of whom exhibited a typical bathing trunk nevus. The negro parents were in good health. A Kline test from the mother was negative. There had been one previous pregnancy. Family history was otherwise negative. The mother was 28 years old and the father 29. The mother had a rather marked anemia during the pregnancy. At birth one infant

Fig. 7.—Case 11 (Andrews). Bathing trunk nevus in association with other smaller nevi.

was noted to have extensive pigmentation of the skin. During the day a weeping excoriation of the skin about the anus of this infant was noted. The anterior fontanel measured 2 by 2 cm.; the posterior fontanel was closed. The head was symmetrical. Examinations of the eyes, ears, nose, pharynx, neck, thorax, heart, and lungs were negative. There were some pigmented spots on the gums. The spine, extremities, and genitals appeared normal. Reflexes were equal on the two sides. Urinalysis was negative. Blood findings: hemoglobin, 22 gm., 100 per cent;

R. B. C., 6,500,000; W. B. C., 7,750. Differential count was not remarkable. The skin over the face and extremities was of light brown pigmentation, while that of the abdomen and thighs was replaced by a giant hairy nevus, the surface of which was dry, cracked, and furrowed. The nevus uniformly covered an area starting at the fourth dorsal spine posteriorly and at a line traversing the upper abdomen diagonally and extending down to the knees on both sides. The penis and scrotum were involved in the large mole. Separation of the buttocks showed the presence of numerous dry excoriations of the surface of the skin which bled easily.

Over the face and extremities there were numerous pigmented nevi, some flat and nonhair-bearing, others elevated and hairy. These varied in size as shown in the illustrations. Over the arms and legs a few subcutaneous nodules were palpated. These were freely movable and did not have the characteristics of neuromas. On March 10, 1936, one of the pigmented moles was excised from the abdomen, and a circumcision was done. The child showed no tendency to hemorrhage. Pathologic examination of the nevus was reported as follows: "Examination of sec-

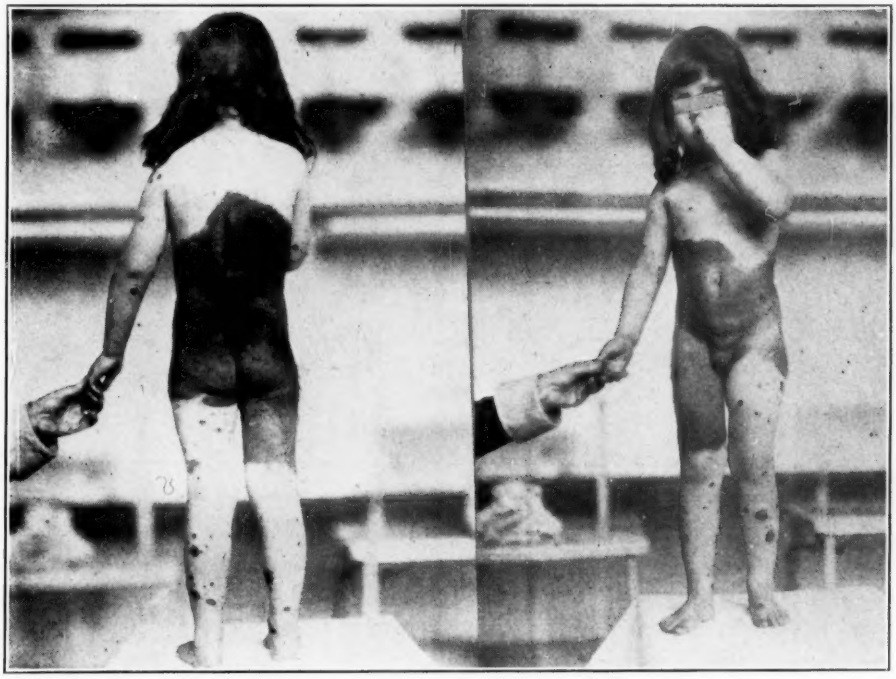

Fig. 8.—(New York Hospital, Case 1.) A female child, 2½ years old, with large pigmented, hair-bearing nevus of the bathing trunk type and elephantiasis of the labium.

tions of the tumor of the skin showed it to consist of epithelium which contained a considerable amount of melanin. Beneath the epithelium was dense fibrous tissue in which there were lymphoblasts and melanophores (pigmented macrophages). Just below the epithelium there were large islands of pigmented cells in alveolar formation. All the cells appeared to be well differentiated and without evidence of malignant change." X-rays of the spine and of the long bones failed to show any evidence of spina bifida or other abnormality.

The child has been followed regularly in the Out-Patient Dispensary of the New York Hospital. He is now 3 years old. He has had repeated colds, one attack of tonsillitis. The child was admitted to the hospital in May, 1936, because of bleeding from the cutaneous excoriations about the buttocks. This condition

rapidly cleared up. In 1936 and 1937 some observers described a mass approximately 5 to 6 cm. in diameter overlying the flare of the left ilium. In 1937, as the child began to walk, a definite limp was in evidence. The left foot was turned slightly outward and the left leg dragged. Moderate scoliosis of the spine with convexity to the left in the thoracic region and to the right in the lumbar region was noted. There was asymmetry of the buttocks and thighs with apparent absence of the left gluteus maximus muscle and atrophy of the muscles of the thigh on the left. The mass previously described near the left ilium was no longer in evidence. X-rays of the spine and pelvis taken in June, 1938, showed no abnormalities other than the mild scoliosis noted above. The circumference of the right thigh was 23 cm., while that of the left was 21 cm. Both calves measured 19 cm. in circumference. The child has shown no evidence of mental retardation. Photographs taken at the age of 2½ years are shown in Fig. 10. The other twin is an apparently normal and healthy child.

Fig. 9.—(New York Hospital, Case 2.) Infant, one of double ovum twins, showing extensive bathing trunk nevus and other smaller pigmented nevi.

A consideration of the particular features of these striking birth anomalies is interesting. It has been pointed out by others that patients who have a bathing trunk type of nevus may have many of the features of von Recklinghausen's disease. In all of the 40 cases of bathing trunk nevus reported herein, the condition has been congenital. Regarding heredity it may be stated that in 25 of the 40 cases, the history of a similar lesion in the family was not within the memory of those from whom the information was obtained. In all of the cases the distribution of the giant nevus corresponded in its upper dorsal limitations to the direction of Langer's lines of elasticity of the skin. Anteriorly and over the inferior demarcations of the nevi this correspondence was not so marked. In 33 of the cases the giant nevi were covered with hair, fine or coarse, long or short. In the other 7 cases the presence of hair on the large nevi was not mentioned. Accessory pigmentation of varying degree was common to 33 cases. In one patient, 508 areas of pigmentation were counted. Cutaneous tumors were recorded in all but 4

of the 40 cases. These were reported as such whether they occurred over the area of the bathing trunk nevus or elsewhere on the body. In many of the case reports information was not given as to the type of tumor. In others the clinical description of the tumor was set down, but no data as to histologic type were given. It is clear from the records that 7 of these 40 patients had cutaneous tumors of the fibroma molluscum type; 8 were reported as having lipomas or fibromas; 6 had pedunculated tumors similar to the pachydermatoceles of von Recklinghausen's disease; 2 had neurofibromas in association with the giant nevus. There was malignant degeneration of the tumors in only 4 cases (10 per cent). Of these, 2 (cases of Jablokoff and Klein and of Bjornboe) were found to have melanosarcoma of the brain. One case was that of a 6½-month-old infant who had a melanotic sarcoma within the area of the bathing

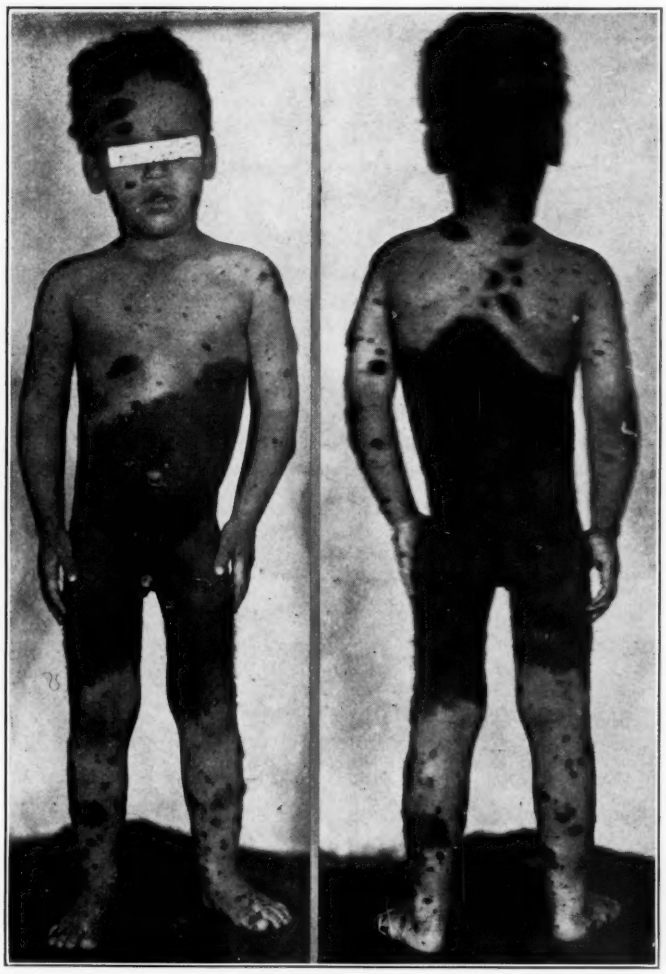

Fig. 10.—(New York Hospital, Case 2.) The same patient as shown in Fig. 9. Photograph taken when child was 2½ years old. Note the underdevelopment of buttocks and left thigh.

trunk nevus and multiple melanotic metastases to the brain. Bjornboe's case was recorded as a primary melanosarcoma of the brain, no evidence of malignant change having been found in the large nevus or in the smaller cutaneous pigmented areas. Autopsy reports were given in only three of the entire group of cases. Atrophy of tumors, as known to occur in von Recklinghausen's disease, was recorded in only one case. The secondary symptoms of that disease, the vague functional, vasomotor, and trophic disturbances, have been reported in only a few instances. Associated congenital anomalies have not been prominent, though hypertrophy of the bones of the skull, prognathism, high palatal arch, and spina bifida have been noted. Heuer's case is the only case of bathing trunk nevus known to have an associated spina bifida. However, this anomaly might escape notice unless x-ray pictures were taken. Several reports have called attention to a "depression" of the spinous processes of the vertebrae and one to a scoliosis of the thoracic and lumbar spine. Meningocele has been associated in only one case. Evidence of hemorrhage into the cutaneous tumors, a significant complication of the tumors of von Recklinghausen's disease, was a complicating factor in the removal of a large tumor in one case. In the case of Cleuet and Ingelbrans a large pedunculated tumor was excised "bloodlessly," while in one of the New York Hospital cases the excision of a similar tumor was complicated by brisk hemorrhage. In one other (New York Hospital, Case 2) minor surgery (circumcision and excision of mole) was not complicated by a tendency to hemorrhage. It is interesting that the case reported by Siemens and Waardenburg should have occurred in one of identical twins, while New York Hospital, Case 2 occurred in one of double ovum twins. In the former case the lesion might be classified more accurately as a vest type of nevus rather than a bathing trunk type. Little is recorded in the literature regarding the vest type of pigmented nevus. Reubens reproduced a photograph of a child with this lesion, stating that it was the only one of its kind in the literature up to that time (1928). Andrews has since reproduced a photograph of a child with a vest type of nevus.

In summary it may be stated that there are 40 authentic case records of congenital hairy nevus of the bathing trunk type, the analysis of the reports pointing to the similarity of features of these subjects and those having true von Recklinghausen's disease.

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ESOPHAGEAL STENOSIS

Spontaneous Stricture in a Young Child Followed by Spontaneous Opening One Year After Tubovalvular Gastrostomy

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ESOPHAGEAL stenosis occurs most commonly at the sites of normal anatomic narrowing which are located, first, at the cricoid cartilage at the level of the fifth cervical vertebra; second, at the crossing of the left main bronchus at the level of the fourth thoracic vertebra; and third, at the esophageal hiatus of the diaphragm level with the tenth thoracic vertebra. Stenosis at other points is quite uncommon, except when due to a malignant growth. One case occurring at the level of the seventh rib is recorded.[1]

The causes leading to stenosis, other than carcinoma, at times may be very obscure, especially when there is no history of swallowing of foreign bodies or corrosive fluids. Congenital malformations, such as atresia, with or without tracheal fistula, complete membranous obstruction (membranous diaphragm), and short esophagus with partial intrathoracic stomach, are frequent causes. Those due to neurologic disturbances are achlasia, cardiospasm, and globus hystericus. Benign tumors include polyp (sessile or pedunculated), lipoma, fibroma, leiomyoma, rhabdomyoma, and angioma. Ulcers may be typhoid, syphilitic, tuberculous, actinomycotic, blastomycotic, or peptic. Inflammatory processes resulting from the swallowing of corrosives are well known, but those which may follow acute infections (diphtheria, etc.)[2] deserve careful attention. Likewise, stenosis may be caused by foreign bodies, arteriosclerosis, varicosities, hyperkeratosis, avitaminosis, and aneurysms. In addition, prolonged physiologic dysfunction in time may produce structural changes leading to stenosis. It seems to us quite likely that some degree of narrowing of the esophagus follows in the wake of the more common acute infections with sufficient frequency to warrant giving careful consideration to the probability of a preceding whooping cough or diphtheria as the etiologic factor in those cases where neither the history nor physical findings give one any other clew. At least our experience seems to warrant this contention.

TREATMENT

All available conservative methods of treatment, of course, should be tried first and surgical interference resorted to only when other measures fail. Repeated dilatation frequently brings relief. In certain cases,

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however, attempts at dilatation are unsuccessful and the patient's condition during this period becomes so poor that quicker and more radical methods of relieving the situation are necessary. The literature contains reports of cases where constricting lesions near or at the cardiac end have been handled successfully by incising the hypertrophic or fibrotic portion down to the mucous membrane. This is an operation similar to that of Ramstedt for congenital pyloric stenosis. Usually, however, these patients are not in condition to undergo any extensive reconstructive work on the esophagus, and it is necessary to employ palliative methods of relief until permanent measures can be safely carried out The case here presented is most unusual in that what was intended to be a palliative preliminary measure proved to be all that was necessary, because the obstruction of the esophagus, which was almost complete at the time of the gastrostomy, after several months began to disappear spontaneously in much the same mysterious fashion that it came.

When stenosis is of such a degree that it is impossible for the patient to take sufficient quantity of food, gastrostomy is a life-saving measure. There are many types of gastrostomy, but the ideal one is that which provides a permanent opening into the stomach which does not tend to close, which does not leak, and which affords opportunity for retrograde instrumentation. It, therefore, must be lined by mucous membrane rather than serosa and must have some sort of valvelike mechanism at the point of outlet from the stomach. The method devised by Spivak,[3] of Chicago, fulfills all of these requirements in a very satisfactory manner.

A case which illustrates this condition very well is that of R. B., a 27-month-old colored female child, who was admitted to our ward at the Cook County Hospital on Feb. 1, 1936. Her history revealed good health until three months previous to admission, at which time she had whooping cough accompanied by considerable vomiting. Subsequently the vomiting became progressively more frequent and she experienced increasing difficulty in taking both liquid and solid food. In fact, during the month preceding her admission to our ward she was unable to keep down even milk. Consequently she lost much weight.

On examination we found a child markedly emaciated and smaller in size than normal. Otherwise there were no positive abnormal findings. The skin was in good condition and there was no evidence of rachitis. Wassermann and tuberculin tests were negative. X-ray films of the chest showed the lung fields and mediastinum to be normal.

A barium mixture was given by mouth and roentgenologic examination revealed a stricture of the esophagus (Fig. 1) at about the level of the seventh thoracic vertebra. Above the point of narrowing, the esophagus was markedly dilated and beyond it a thin stream of barium could be followed about 2½ inches before it entered the stomach. When more barium was given, she regurgitated the entire amount above the stenosis.

The child was given a good quantity of dextrose intravenously and by mouth frequent small feedings of nourishing liquids. Only a small amount of food taken, however, passed beyond the stricture, the remainder being regurgitated a short while after being swallowed. Esophagoscopy revealed a narrowing the size of a

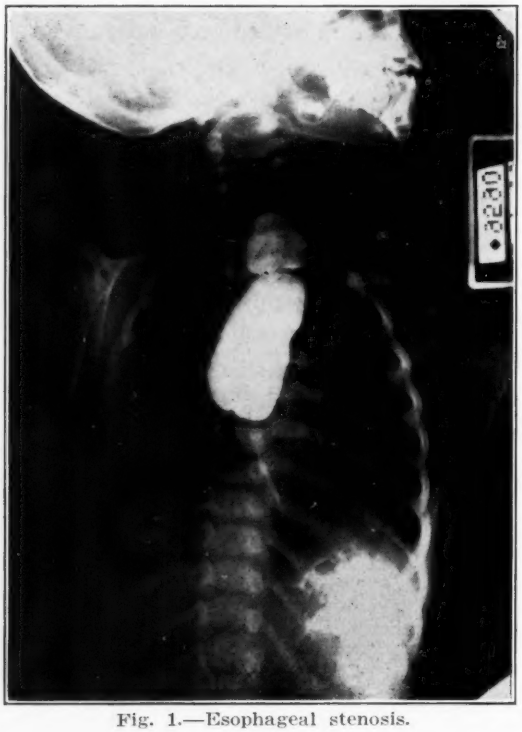

Fig. 1.—Esophageal stenosis.

Fig. 2. Fig. 3.

Fig. 2.—Showing gastrostomy opening.
Fig. 3.—About four and one-half months after closure of gastrostomy.

matchhead about half-way down and several attempts to pass a bougie failed. Likewise, many attempts to have her swallow a string were unsuccesstul, and it finally became necessary to proceed with a gastrostomy. This was done April 9, 1936, using the Spivak tubovalvular method.[3] The approach was made through the left rectus and the mucus-lined tube brought to the surface at the upper end of the incision near the costal margin (Fig. 2).

The postoperative course was very smooth. On the fifth day a small catheter was passed into the stomach and small amounts of water and milk were given. The quantity was increased each day and gradually puréed vegetables were added to her diet. She gained rapidly in weight and strength. The wound healed without infection. About the margins of the everted mucous membrane a small amount of skin irritation occurred, but it was easily controlled by the application of heavy magnesium oxide, and before long only a strip of vaseline gauze was needed to protect the skin from the action of the gastric juice secreted from the lining of the tube. It was interesting to note that the sphincter-like action at the base of this tube was so perfect that even after large feedings no amount of activity or change in position resulted in a spill and this fact was accurately verified by the x-ray after adding barium to the food.

The child gained in health rapidly and to the surprise of everyone it was noted that in March, 1937, almost a year after the gastrostomy was performed, she was able to swallow and retain considerable liquid food. It soon became easy to pass a small catheter into her stomach, and, also, barium given by mouth no longer accumulated above the point of obstruction. In other words, the stenosis, which upon her admission to the hospital and for eleven months thereafter had been almost complete, had gradually opened up spontaneously, permitting the patient gradually to resume her normal method of taking food. On Sept. 8, 1937, one and one-half years after her operation, she returned to the hospital, fat and strong, for closure of the abnormal opening into her stomach. Since then she has been frequently observed and her progress has been very uneventful (Fig. 3).

COMMENT

Even in a small stomach it is possible in constructing this type of gastrostomy to form a mucous membrane-lined tube of sufficient strength and diameter to function adequately. The base of the flap in the anterior wall of the stomach may be either toward the lesser or greater curvature. The two most essential points in the technique are (1) the formation of the fold to act as a valve at the base of the tube and (2) the construction of the reinforcing cuff which gives it the sphincter-like control. This area is the weakest point and the place where leakage is most apt to occur, hence the necessity for very careful placing of the sutures, without penetrating the mucosa or interfering with the blood supply.

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A SIMPLIFIED BLOOD TRANSFUSION SET

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FOR the past eighteen months we have been using an inexpensive, indirect transfusion set which eliminates pouring of blood, keeps it mixed, filters it as given, and readily shows the rate of flow.

Donor's Set (Fig. 1, *1*).—A standard 1,500 c.c. flask with overlapping stopper provided with two tubes is used to collect the blood. One tube is connected to a venepuncture setup and the other is joined to a suction pump. Sodium citrate (2.5 per cent) and then blood are drawn into the flask. The rubber stopper then can be easily removed aseptically. The mouth of the flask is then covered by a second stopper or sterile gauze sponge until the blood is given.

Recipient's Set (Fig. 1, *2*).—This consists of a stopper with air vent, filter and tubing attached. The vent is an ordinary 20 c.c. soft glass pipette cut off and bent as shown. The filter is a 25 mm. glass laboratory funnel bent in on one side to permit complete emptying of the flask. Gauze filters are stretched over this and over the long end of the air vent.

This set is wrapped in a shallow pan to prevent breakage.

Giving the Blood (Fig. 1, *3*).—The recipient's set is attached to the blood flask by inserting the special stopper. The tubing is clamped and the flask inverted into a C-shaped ring clamp attached to a standard. Bubbles in the tubing are to be avoided. This is done by holding the tubing high, opening the clamp, and then slowly lowering the tube as it fills. Semitransparent gum rubber tubing is used. A three-way valve is employed to attach syringe and needle for venepuncture.

As blood flows, the level slowly falls in the side arm, or vent, which empties and refills as each 5 or 6 c.c. of blood passes to the patient. This allows the same volume of air to bubble up through the blood for mixing. The side arm, then, is a delicate indicator of blood flow. The time required for it to empty, of course, gives the rate of flow. This is advantageous because with many sets it is difficult to estimate the rate of flow or even to decide if the blood is flowing at all.

Used With Saline Solution or Glucose.—We prefer to give fluids with blood usually, and now always employ the recipient's set shown in Fig. 1, *4*. The glass plunger can be attached to standard solution flasks used in the hospital. After applying clamps to both tubes, the blood and solution are inverted together with the latter at a higher level (Fig. 1, *5*).

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The tubing is first filled with saline solution, after which a small volume is allowed to flow into the blood flask to displace the air between the Y-tube and the blood flask. Blood or saline solution can then be given to the patient.

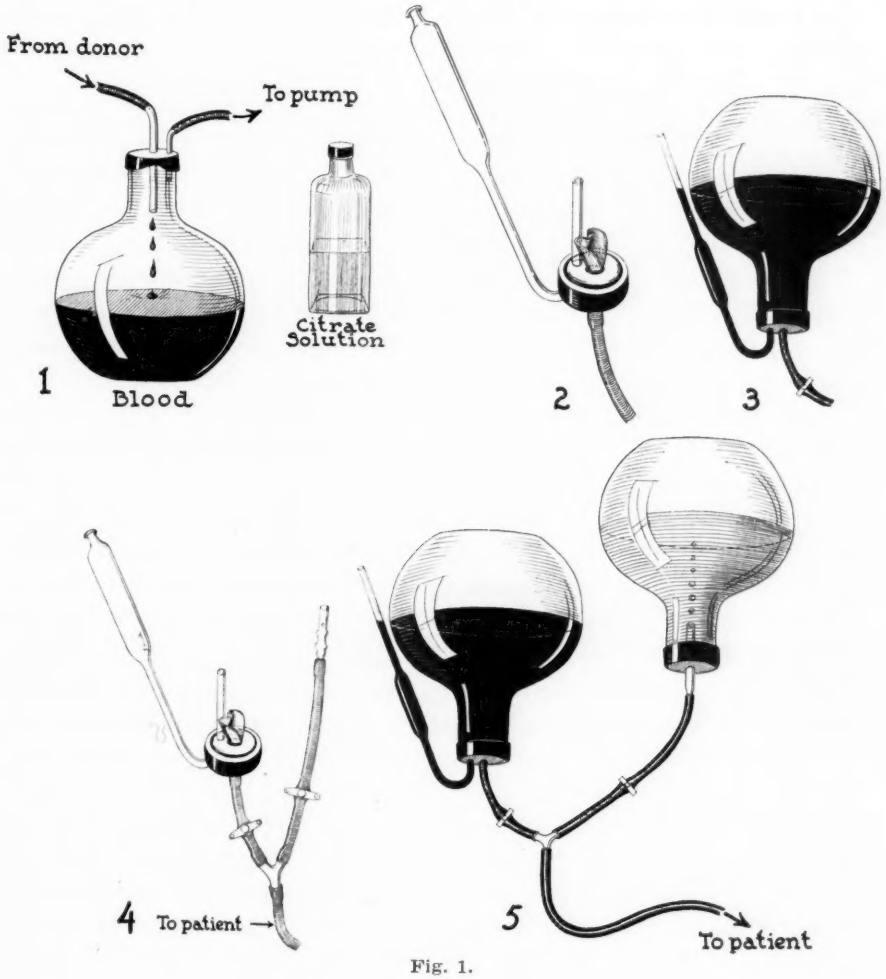

Fig. 1.

COMMENT AND CONCLUSIONS

This method eliminates pouring and flaming. We feel that it offers better aseptic technique and greater safety where explosive anesthetics are being used. It has the additional advantages of keeping the blood mixed and of readily showing the rate of flow.

PRIMARY TUBERCULOUS PERIPHERAL VASCULAR DISEASE

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IN THE classification of diseases producing chronic peripheral vascular deficiency, tuberculosis is given a place. This place, however, is but little substantiated in the literature by specific examples of primary tuberculosis producing obstruction in peripheral vessels.

Secondary involvement of large blood vessels by extension of tuberculosis has often been reported, a common sequela being aneurysm formation. Baumgarten and Cantor[1] collected twenty cases caused by proved tuberculous arteritis. Of these twenty cases, four were considered not to be the result of direct extension but rather of hematogenous infection of the vasa vasorum. The case reported by Baumgarten and Cantor was that of an aneurysm of the femoral artery, so destructive that amputation of the leg was necessary. No primary tuberculous focus was found and the patient was alive and well three years later. The pathologist's report showed that all three coats of the artery had many tubercles. Without evidence of tuberculosis elsewhere, this can be considered as a primary tuberculous arteritis of a large vessel.

Tuberculous phlebitis secondary to tuberculosis elsewhere in the body is reported not uncommonly, and when seen in advanced cases of pulmonary tuberculosis has long been considered a poor prognostic sign. Whether the phlebitis results from the cachexia and peripheral venous stasis associated with the disease or whether caused by specific tuberculous lesions of the vessels is not entirely clear. Dodwell and Lond[2] in 1893 reported twenty instances of venous thrombosis in patients with advanced pulmonary tuberculosis, but autopsy studies showed no specific lesions in the vessels involved. Halbron and Paraf[3] cultured the blood clots from the thrombosed peripheral vessels of another series of thirteen such patients and in only four instances were the cultures positive for tubercle bacilli. However, guinea pig inoculation with blood clot from four other similar cases brought positive results in each case. These observations might well be explained by a terminal bacillemia, especially in view of the fact that microscopic examination of three of the veins failed to show any changes typical of tuberculosis. Ferrari and Fosatti,[4] in a similar study, were unable to demonstrate a specific etiology for the peripheral thrombosis seen in advanced pulmonary tuberculosis.

Also associated with pulmonary tuberculosis is a type of phlebitis characterized by involvement in rapid succession of many superficial

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veins, followed by quick local recovery. Bernard, Solomon, and Coste[5] found this condition in individuals with advanced pulmonary tuberculosis, but Hirtz[6] reported and Lafforgue[7] described the condition in persons without discernible tuberculosis at the time of the first examination. Further examinations have showed that a large number of these latter patients developed miliary tuberculosis. Lafforgue[7] terms the condition "la phlébite précoce des tuberculeux pulmonaires" and believes in the specific etiology of the lesions. Their bacteriologic and pathologic proof, however, are lacking, as all cultures and microscopic studies failed to show either tubercle bacilli or their typical lesions.

Altschüler[8] describes two patients with peripheral thrombophlebitis of a recurring nature which on biopsy showed intimal tuberculosis of the veins. Neither had evidence of tuberculosis elsewhere in the body.

The case we wish to report, that of a patient losing fingers and toes as a result of a chronic peripheral vascular deficiency due to localized tuberculosis, is decidedly uncommon. It is the only instance of this condition among the large number of persons treated for peripheral vascular disease at the University Hospital in the past ten years.

CASE REPORT.—H. S., No. 330664, a 35-year-old white male, was first seen at the University Hospital, February, 1934, with a chief complaint of cold, dusky extremities and intermittent sores and infections of fingers and toes.

Twenty years before the patient had "frozen" his hands and feet. Ten months before entry the third finger of the left hand was injured, did not heal, so was partially amputated. Four months before entry a black blister developed on the right great toe and continued to "eat in," so the toe was amputated. Numerous other sores healed with the loss of some tissue. There had been cramping pain in the calves upon walking and a few painful nodules had appeared in the skin of the legs. There was no family history or known contact of tuberculosis. Health, other than the present illness, had been good.

Physical examination on entry showed a well-developed and well-nourished white male. Lung fields were clear; heart, normal; blood pressure, 112/70; abdomen, normal. There had been an amputation of the left third finger through the middle phalanx; the stump showed active ulceration and inflammation. The left fourth finger was deformed from partial loss of the distal phalanx. The circulation in the forefeet appeared to be poor, the skin was paler than normal, the veins were poorly filled. There was moderate rubor of the feet on dependency and pallor on elevation. The right great toe had been amputated and the left great toe was cyanotic and tender. The distal pulses were as follows:

	RIGHT	LEFT
Radial artery	Good	Good
Ulnar artery	Not felt	Not felt
Posterior tibial artery	Very weak	Not felt
Dorsalis pedis artery	Fair	Very weak

The skin temperature environmental response showed a moderate degree of organic vascular occlusion. The urine and Kahn tests were normal. A leucocytosis of 10,000 to 14,000 per cubic millimeter was present on several occasions. A roentgenogram showed the chest to be normal.

A diagnosis of organic peripheral vascular deficiency was made. The disease was not considered to be typical of thromboangiitis obliterans, although suggestive of it. A sinus tract on the third right finger was curetted and a biopsy was made from an

area of recent superficial phlebitis in the left calf, which was reported* as follows: "Obliterating tuberculous phlebitis. The media and adventitia show but slight involvement as compared to the intima in which the process is granulomatous, avascular, epithelioid and caseating. Final occlusion has been accomplished by a thrombus which is now showing early organization." The sinus curettings showed "fragments of necrotic bone, granulation tissue, and masses of caseous necrotic material. No tubercles in this tissue, but might well come from an area of tuberculous osteomyelitis." A high and low power photograph of a typical microscopic section from the calf vein is shown in Fig. 1. The finger healed in two weeks and the patient was discharged.

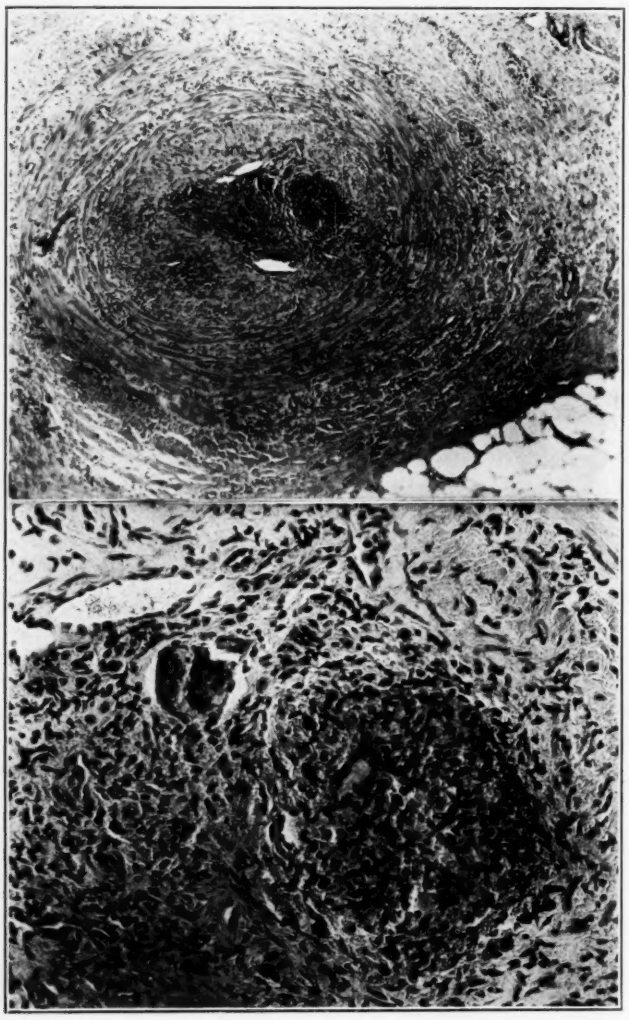

Fig. 1.—Obliterating tuberculous phlebitis of right calf vein.

The patient was well for eight months until the cold weather of November, 1934, when the left great toe became swollen and was lanced several times. In February, 1935, the left fourth finger became swollen and was incised, and during these winter months the patient had great trouble in keeping his hands and feet warm. In March, 1935, the patient was readmitted to the hospital with pus draining from the left fourth finger and from the amputation stump of the left great toe. Wide drainage

was obtained and the conservative measures employed in the treatment of a peripheral vascular deficiency were again instituted. The response was extremely slow. A long area of phlebitis developed on the dorsum of the left forearm in September, 1935, was biopsied, and reported* as "a vein somewhat larger than the one examined from the leg, and showing a productive granulomatous intimitis with final obliteration from thrombosis. In the granulomatous tissue, partially filling the lumen, are numerous nodular formations of epithelioid cells and giant cells with slight central

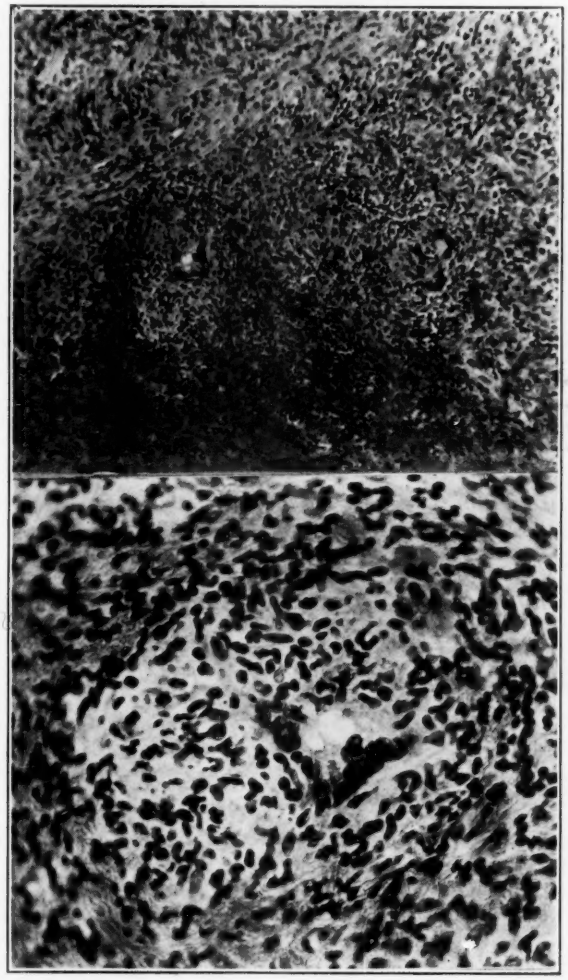

Fig. 2.—Obliterating tuberculous endophlebitis and phlebitis of left forearm vein.

caseous necrosis. Histologically these resemble tubercles in every respect. Obliterating tuberculous endophlebitis and phlebitis." A high and low power photograph representative of the tissue removed is shown in Fig. 2. The left fourth finger was reamputated twice and a midpalmar space infection was drained. By January, 1936, the hand had healed and only a slight amount of pus drained from the sinus in the left great toe. The patient's general condition was excellent and chest roentgenograms again showed no evidence of tuberculosis.

*All pathologic diagnoses were made by the Department of Pathology, and the authors wish to express their appreciation of the aid given by its chairman, Dr. C. V. Weller.

In October, 1936, the patient was again seen with a complaint of difficulty in keeping his hands and feet warm. At this time no pulsation could be felt along the radial, ulnar, dorsalis pedis, or posterior tibial arteries. The tip of the left index finger showed a small, very tender ulcer, and tissue removed from the edge of the ulcer was reported as "fibrino-purulent exudate, caseation necrosis but no definite tubercle formation, purulent osteomyelitis." With out-patient dressings, the ulcer was healed in three months' time.

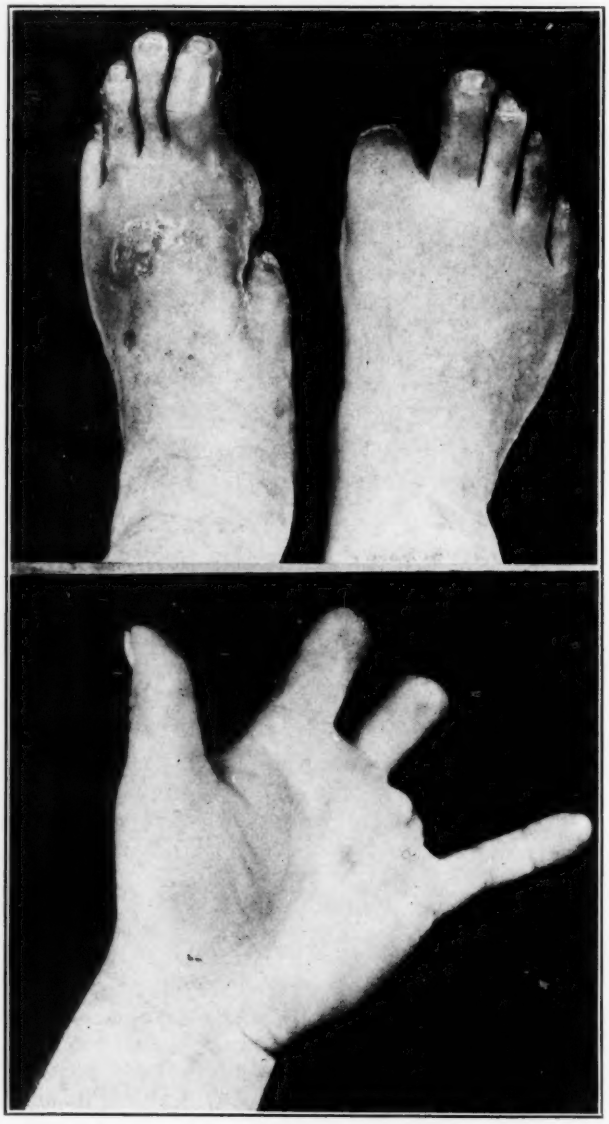

Fig. 3.—Deformities of left hand and the feet four years after original admission.

The last examination of this patient was in May, 1938, four years after the original admission. Fig. 3 shows the deformities of the left hand and the feet at that time. The patient's general health was excellent, but he had been unable to work for the previous six months because of recurrent ulcerations of his feet. Again there was no evidence of systemic tuberculosis, and x-rays of the feet showed no

active bone lesions. Various measures stimulating the peripheral circulation were instituted, but progress towards the healing of the ulcers was slow.

COMMENT

Although guinea pig inoculations and cultures were not done and special stains for tubercle bacilli were negative, we believe that the pathologic picture warrants a diagnosis of primary peripheral vascular tuberculosis. The clinical aspects of the patient were those of a chronic vascular deficiency and the course of the disease has been somewhat similar to that of thromboangiitis obliterans. With treatment, areas of involvement have healed and new lesions have developed later.

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A SIMPLE METHOD OF APPLYING HEAD DRESSINGS

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MOST injuries to the scalp are covered with a bulky head dressing which is held in place by roller bandages. These are conspicuous and often uncomfortable. Many times the patient is not overly anxious to have his head wound advertised by a large dressing. Collodion dressings are often used for this type of dressing but are far from ideal. These dressings are annoying to apply and difficult to remove. A scalp dressing has been described[1] which is held in place by tying locks of hair together with silk. In some cases it is efficient, but in short-haired individuals it is not possible.

A simple head dressing is here presented which is easily applied and removed. A gauze pad is applied over the wound and strands of hair are pulled over each edge of the pad. A small piece of adhesive tape, which is just large enough to cover the ends of hair, is applied. (Fig. 1.)

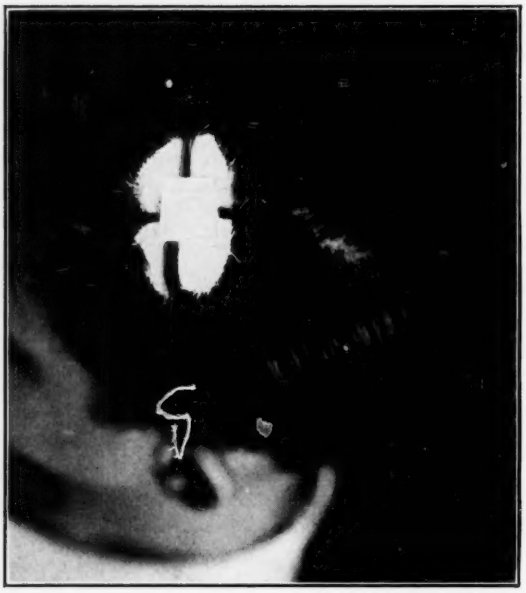

Fig. 1.

Due to the oil in most hair, it is advisable to moisten the adhesive tape with ether before its application. The bandage is painlessly and rapidly removed by dampening the adhesive tape with ether and gently pulling it away from the locks of hair. It can be seen from the illustration that dressings of varying size may be applied which are light, comfortable, and inconspicuous and which may be changed as often as needed.

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Editorial

A Present-Day Appreciation of Beaumont's Experiments on Alexis St. Martin

BEHIND every experiment is a man. The character and the mental attitude of the man bear on the character of his observations and their interpretation. Hence, it is appropriate, first, to depict the character of the man, Beaumont. This can best be done by using his own statements.

"I had opportunities for the examination of the interior of the stomach . . ." "I have availed myself of the opportunity afforded . . ." "I submit a body of facts which cannot be invalidated." "The reader will perceive some slight seeming discrepancies . . . ; but he will recollect that the human machine" is subject to some variation in the same and different individuals . . . "I am fully aware of the importance of the subject . . . ; I am therefore willing to risk the censure or neglect of critics, if I may be permitted . . . to be the means, either directly or indirectly, of subserving the cause of truth, . . ." "I make no claim to originality in my opinions, . . ." "I consider myself but a humble inquirer after truth—a simple experimenter." "My opinions may be doubted, denied or approved, . . . ; but their worth will be best determined by the foundation on which they rest—the incontrovertible facts." "Truth, like beauty, when 'unadorned, is adorned the most,' and, in prosecuting these experiments and inquiries, I believe I have been guided by its light." More inspirational statements cannot be found in the writings of any other scientist.

It is no wonder that a man imbued with such a spirit made many observations, all of which have been confirmed. Certain of his interpretations were in error, but it must be remembered that Beaumont worked with only a "gum-elastic tube," a magnifying glass, a scale, a thermometer, an incubator consisting either of a basin of water on a sand bath or an armpit, a muslin filter, nutgall, and his five senses. Moreover, in his day the science of physiology was barely an embryo, particularly in the field of digestion. Thus, certain of his interpretations were erroneous, not because of an error in observation but because the observations have since assumed a new meaning which either was not or could not have been recognized by Beaumont. Yet, even today, one marvels at the high degree of accuracy of his fifty-one inferences, or conclusions, listed on page 200 of *Life and Letters of Dr. William Beaumont* by Dr. Jesse A. Myer.

In Inference 24 Beaumont states that gastric juice "contains free muriatic acid and some other active chemical principles." In another place he states: "I had been long convinced of the existence of free muriatic acid in the gastric fluids. Indeed, it is quite obvious to the sense of taste . . ." Yet, in some of his classic experiments on artificial digestion he added muriatic acid and acetic acid to water. In Experiment 104 he used "four drachms of a mixture of dilute muriatic and acetic acids, reduced with water to the flavor of the gastric fluid, as nearly as practicable—three parts of the muriatic to one part of the acetic . . ." Does this mean that Beaumont was able to detect by taste a difference between the free and total acidity of gastric fluid, or was he misled by the odor of the gastric contents of the bibulous St. Martin?

Beaumont's scientific method of conducting experiments proved that something is present in gastric juice other than acid which facilitates digestion. He showed that gastric juice digested meat at body temperature much better than at room temperature and that gastric juice was a better digestant than dilute muriatic acid. If he had boiled gastric juice, he would certainly have discovered pepsin, and perhaps rennin. However, his experiments on artificial digestion were far in advance of his day, and it appears that Beaumont's suggestion led to the discovery of pepsin in 1836 by Schwann, who refers to Beaumont.

The following passages briefly outline Beaumont's observations and opinions, which render him partly responsible for promulgating three erroneous views. There is nothing wrong with the observations; in fact, they are classic; only their interpretation is misleading. In Inference 25 Beaumont states that gastric juice "is never found free in the gastric cavity; but is always excited to discharge itself by the introduction of food, or other irritants." In Inference 14 he states that "hunger is the effect of distension of the vessels that secrete the gastric juice." In his discussion (p. 59)* he states: "On applying aliment to the internal coat of the stomach . . . the orifices, undoubtedly, of the gastric vessels, immediately throw out a quantity of the fluid, which mixes with the food . . . when the stomach is destitute of food or some other irritating substance, no such secretion can be found in it. And it is more than probable . . . that a large quantity of this fluid must be contained in appropriate vessels, during a fast, ready to obey the call of aliment. I would not be understood to say that the whole quantity necessary for an ordinary meal is eliminated from the blood, previous to the commencement of alimentation; but that enough is contained in the gastric vessels to produce the sensation of pain and hunger." He points out that hunger distress is almost immediately relieved when a little food causes the juice in the gastric vessels to be extruded. Regarding the secretion of the fasting stomach he says: "The gastric juice never appears to be ac-

*Beaumont, William: Experiments and Observations on the Gastric Juice and the Physiology of Digestion, Plattsburgh, 1833.

cumulated in the cavity of the stomach while fasting; and is seldom, if ever, discharged from its secreting vessels, except when excited by the natural stimulus of aliment, mechanical irritation of tubes, or other excitants'' (p. 105). Yet, the protocols of many of his experiments show that he obtained from one-half to two and one-half ounces of acid fluid from the fasting stomach. His interpretation (p. 137) was: ''I infer that the fluid, in these experiments, was incidented to discharge itself by the irritation of the tube used in extracting it.'' In Experiment 63 (p. 207) is found the following interesting observation: ''There was no free fluid in the gastric cavity, until after the elastic tube was introduced, when it began slowly to distill from the end of the tube, drop by drop, perfectly transparent, and distinctly acid. I obtained about one drachm of this kind, and then gave him a mouthful of bread to eat. No sooner had he swallowed it, than the fluid commenced flowing more freely from the tube, and I obtained two drachms, less pure, however, with saliva and mucus mixed with it, and slightly tinged with yellow bile. The surface of the protruded portion of the villous coat at this time became covered with a limpid fluid, uniformly spread over its whole surface, distilling from myriads of very fine papillary points, and trickling down the sides.'' Later he ''introduced the tube and obtained about two drachms more of very pure gastric juices.'' It is clear that Beaumont believed that hunger distress was due to distention of the gastric glands with stored gastric juice, that the secretion he found in the empty stomach was due to the mechanically excited extrusion of the stored secretion, that contact of food with the gastric mucosa caused secretion by the chemical action of the food on the mucosa, and that the sudden response of the gastric glands to swallowed food was due to the chemical stimulation of the food in contact with the gastric mucosa.

In retrospect, if Beaumont had emptied the stomach completely and then had in some instances collected for a half-hour the continuous secretion of the stomach and then had manipulated the mucosa with his thermometer, he would have found no sudden discharge on mechanical stimulation of secretion. If he had distended the stomach, he probably would have found that mechanical distention, the only significant and adequate mechanical stimulus, would stimulate. Having found that gastric juice was not stored in the gastric glands, he would not have proposed his theory of hunger. Also, if he had told St. Martin to take the bread in his mouth and chew but not swallow it, he would have discovered the psychic secretion of gastric juice, which he actually observed without realizing it. Further, if Beaumont had associated the pain in the pit of the stomach, which he produced when he caused St. Martin's stomach to contract by irritation with the thermometer bulb, with the pain of hunger, he would probably have recognized that hunger pain was due to gastric contractions. Beaumont's idea that the gastric juice secreted in fasting was stored in the gastric glands caused him to mis-

interpret hunger distress, to believe that the empty stomach frequently does not secrete acid, and perhaps to miss the discovery of psychic secretion or the effect of nerves on secretion. In his day, of course, the concept of secretory nerves had not arrived. The existence of secretory nerves was proved by Ludwig in 1851, and the concept was prevalent when Bidder and Schmidt in 1852 first recorded the observation of the psychic secretion of gastric juice.

According to the implications of his own statements, Beaumont derived his turgescence theory of the hunger sensation from his belief that the mucosa of the stomach is analogous to erectile tissue. He refers to "the erectile tissue of the villous coat of the stomach." In reference to the hunger sensation he says: "The sensation varies according to the different degrees or states of distension, from the simplest desire to the most painful sense of hunger." He writes, further, of "the pain from acute inflammation by distension of blood vessels," of "the effect of vascular distension of blood vessels," of "the quiescence and relief from the unpleasant sensations which are experienced as soon as the vessels are emptied." He answers the possible criticism that the accumulation of gastric juice in the vessels might rupture by pointing out that "this apparatus is constituted like many other organs—and permits absorption of its secretions, so they do not rupture." "The male semen is constantly being secreted, and deposited in its proper seminal vessels, ready to be ejected," yet it is "taken up—by absorbing vessels, as the gastric juice is." He was apparently much impressed by the phenomena of the blushing and blanching of the gastric mucosa, and hence compared the phenomena with those vascular changes and sensations manifested by erectile and inflamed tissue. He overlooked the intermittent and recurrent character of hunger pains, which is experienced by most persons if they fast long enough.

Beaumont unequivocally distinguished between mechanical and chemical stimulation of the gastric glands. He discovered that certain foods act as chemical excitants of the gastric glands, and he demonstrated unequivocally that oily food is difficult to digest. He showed, but was not the first to do so, that bile aids the emulsification of fat. He knew that bile was alkaline, but suspected that pancreatic juice (p. 164) was slightly acid. He believed that saliva has no digestive action, that it only lubricates. This view was probably based on the fact that he added saliva to gastric juice, the acidity of which inactivated the ptyalin, and, being on the frontier, he was not acquainted with the discovery of Leuchs (1831) that saliva liquefies and decomposes cooked starches.

Most of Beaumont's experiments on the rate of digestion are classics. However, he could not distinguish between what we now call enzymatic digestion and chymification. He proved that vegetables, especially large pieces of raw or cooked vegetables, were more difficult of digestion, or rather chymification, than meats and farinaceous foods. Because he

did not know of the digestive action of saliva on cooked starch he surmised, on the basis of filtration and sedimentation, that gastric juice dissolved starches. If chymification is substituted for digestion in Beaumont's statements regarding the changes the minutely divided vegetables underwent in his experiments, little objection can be made to his interpretations.

The movements of the pyloric portion of the stomach were remarkably well described by Beaumont when it is considered that he had to infer what was happening by feeling through the aid of his thermometer. In regard to the movements of the fundus of the stomach, he described a rotary motion of the contents, which he said was not "very exact," the contents being "intimately mixed and circulating promiscuously." His emphasis on the rotary motion (p. 110) was probably due to the pathologic fixation of St. Martin's stomach. Yet, he observed that the movements of the fundus increase as digestion progresses; and, in his conclusions, he states correctly that "the movements of the stomach produce a constant churning of its contents" and "that these motions are in two directions—transversely and longitudinally."

In regard to the effect of emotions, overindulgence in food and drink, and febrile conditions on the appearance of the stomach, every modern gastroscopist would profit by reading Beaumont's descriptions of the gastric mucosa as affected by these conditions. In this connection a statement made by Beaumont should be quoted (p. 240) for emphasis: "It is interesting to observe to what extent the stomach, perhaps the most important organ of the animal system, may become diseased, without manifesting any external symptoms of such disease, or any evident signs of functional aberration."

One truly does not know gastric physiology and pathology as one should until Beaumont has been read critically and *in toto*. It should be emphasized that many important observations are not mentioned in his list of fifty-one inferences. For example, among his observations, he records that hot, humid weather depresses gastric secretion, that the temperature of the pyloric antrum is higher than that of the fundus, that too much cooking hardens the food so that it is not easily digested, that too much condiment irritates the gastric mucosa, that the appearance of the tongue is an indicator of the healthy or unhealthy state of the stomach, that the mechanical action of a muslin bag containing food and prevented from passing the pylorus by means of a string irritates the gastric mucosa, that the cardiac sphincter visibly opens and closes after swallowing, and that thirst "is felt in the mouth and fauces" and "the proximate cause may exist in an irritation, a kind of sub-inflammation of the mucous membranes of the mouth and fauces, the effect of the viscid state of the blood, and consequently impervious state of the secretory vessels of these membranes." These and many other impor-

tant facts may be gleaned only by reading all of the 279 pages of Beaumont's *Experiments and Observations on the Gastric Juice and the Physiology of Digestion.*

Beaumont's observations not only provided many important new facts, but they also suggested a new method of approach to the study of gastric physiology and directly and indirectly stimulated a tremendous amount of investigation.

At the meeting of the International Congress of Physiologists in Boston in 1929, each guest was presented with a medallion bearing the likeness of Beaumont and a facsimile of the original edition of his book. William Beaumont, the frontier physician and physiologist, on this occasion, was figuratively canonized as the patron saint of American physiology. Modern American physiologists can pay no greater honor and respect to any man.

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Chicago, Ill.

Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

RECENT ADVANCES IN SURGERY OF THE ESOPHAGUS

CLARENCE E. BIRD, M.D., PROVIDENCE, R. I.

CONGENITAL DEFECTS

Atresia With Tracheoesophageal Fistula.—Mixter (1936) reported that during a period of ten years twenty-three cases of atresia of the esophagus with tracheoesophageal fistula were seen at the Children's Hospital in Boston. Although it is an uncommon anomaly, any surgeon may be confronted by such a case. The tract usually exists between the lower segment of the esophagus and the trachea, rarely between the lower segment and a main bronchus. A. D. Smith (1937) performed an autopsy on an infant with a still less common communication between the upper esophageal pouch and the trachea.

The uniform symptoms, which are regurgitation of milk and mucus, with attacks of choking, cyanosis, and coughing, occur when the infant is first fed. A plain roentgenogram of the abdomen shows the stomach and sometimes the intestines filled with air (van Gilse, 1924; Vogt, 1929; Reid, 1932; Solis-Cohen and Levine, 1936), thus proving the presence of a tracheoesophageal fistula (which occurs in about 75 per cent of the cases of atresia), as distinguished from the far less common complete or incomplete atresia of the esophagus without a fistula (25 per cent). Nothing further is necessary to establish the diagnosis, and injection of barium or lipiodol (Brockington and Lightwood, 1933) in order to demonstrate the blind pouch or the fistula may prove harmful (Scott, 1939,* and others). It is important to search for associated anomalies, which are present in about 60 per cent of the cases, excluding open foramen ovale and ductus arteriosus. The anomalies are often compatible with life. In about 30 per cent the defect is anal atresia (Plass, 1919).

As Blair (1936) pointed out: "If you are going to do anything radical in an infant, do it at the earliest possible moment and you will be most likely to succeed." This is especially true in an infant with tracheoesophageal fistula, because prevention of the repeated aspiration of septic material into the lungs is fundamental if a cure is to be hoped for.

*In one of Scott's infants whose stomach was transected and who died five weeks later, autopsy showed multiple lung abscesses surrounding deposits of barium which had been injected for diagnostic purposes before Scott saw the patient.

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Evidence has accumulated to show that gastrostomy or jejunostomy, with or without ligation of the lower esophagus, is futile (e.g., Smith, 1923; Simpson, 1929). Aspiration bronchopneumonia occurs uniformly.

Before any operation is attempted, it is important to provide adequate amounts of fluid and dextrose parenterally. The child must be kept warm. At operation, manipulation must be gentle. Anesthesia should be local. If an inhalation anesthetic is attempted, especially under positive pressure, the stomach will inflate with gas forced through the fistula.

The essential surgical problem is to prevent drowning of the lung either through the fistula from below or by overflow into the trachea from the blind esophageal pouch above. The earliest rational attempt to cure these patients was made by Richter (1913), who in two cases closed the fistula by right transpleural thoracotomy followed by gastrostomy. One infant died of "shock," the other of aspiration pneumonia which had begun before operation. Although several authors refer to Richter's work with admiration, no further progress appears to have been made until 1934, when Iglauer proposed, but did not carry out, a program of cure based partly on the diagnostic work of Tucker and Pendergrass (1933). In a typical case, the latter authors: (1) aspirated the upper blind pouch through a 3.5 mm. esophagoscope, introduced a small amount of bismuth mixture, took roentgenograms, then aspirated the bismuth; (2) introduced a 3.5 mm. bronchoscope, located the fistula, and passed a ureteral catheter through the opening into the lower esophagus and stomach. Gastrostomy and intra-abdominal ligation of the lower esophagus followed, but, as always, the child died of aspiration pneumonia.

Iglauer's plan was as follows: (1) cervical esophagostomy in one or two stages, depending on whether or not the blind sac could be brought to the skin; (2) the placing of a specially prepared ureteral catheter through the fistula into the lower esophagus; (3) right posterior, transpleural thoracotomy, closure of the fistula, exteriorization of the stump of the lower esophagus for tube feeding into the stomach; (4) tight closure of the uncontaminated thorax with lungs expanded under positive pressure. The ureteral catheter was to be prepared by: (1) sealing the tip with paraffin to prevent insufflation of the stomach, (2) applying a rubber collar to occlude the fistula, and (3) perforating the catheter above the collar to allow insufflation of ether vapor under positive pressure. The fistula was to be ligated and severed through the catheter, thus allowing the catheter to be drawn up only slightly in order to sew over the opening, then to continue the insufflation. This theoretically promising program seems never to have been carried out.

In 1936, Gage and Ochsner reported two failures after ligation of the lower esophagus and gastrostomy. In discussion, Mixter stated that in 1929 he had severed the fistula by a posterior approach and then brought the esophagus out at the back for feeding. After several futile opera-

tions of this kind, he added a cervical esophagostomy either at the primary operation or within a few days. All patients so treated died.

In the same year, Bohrer, in a discussion of Leven's paper, described a similar procedure, but by an anterior extrapleural approach. This was made by resecting the left fourth costal cartilage and adjacent section of rib, displacing the pleura and lung, and exposing the fistula. The fistula was divided and closed and the stump of the elastic esophagus was easily brought out through the wound for feeding. Bohrer had found the approach satisfactory. The child was in poor condition before operation and died shortly, but he thinks the procedure feasible.

Leven (1936) adopted an entirely new principle, which is promising. The two infants he reports upon lived ninety-eight and fifty-three days, respectively. In each case, at the earliest possible moment consistent with adequate administration of fluids, he opened the abdomen under local anesthesia in the upper midline and gently lifted up the stomach and angulated it out of the wound. A tube was introduced toward the pylorus for feeding. The lungs and lower esophagus drained themselves continually into the isolated upper segment of the stomach, which was kept dry by aspiration. Leven prevented overflow into the lungs from the blind cervical esophageal sac by repeated aspiration of the mouth and pharynx with a bulb syringe. He advised against either a transnasal or transoral inlying catheter because of the great danger of ascending infection through the Eustachian tubes, which in infants lie more horizontally than in adults. This point was corroborated by Wangensteen in discussion.

Gamble (1938) used the same principle, but severed the stomach (as had Scott), used the exteriorized upper stump to drain the lower esophagus, closed the lower stump, and added a gastrostomy for feeding. This infant died on the fifteenth postoperative day, not of pneumonia, but from hemorrhage and generalized peritonitis, the result of perforation of an ulcer on the anterior wall of the lower segment of the stomach.

Scott (1934) operated upon an infant on the second day after birth; transection of the stomach and gastrostomy were carried out as one procedure. The child lived four and one-half months; at autopsy there was purulent bronchitis with slight interstitial pneumonia. Scott believes that acid secreted by the upper gastric segment may irritate the tracheal mucosa and proposes leaving a minimum gastric stump, the mucosa of which should be destroyed so far as possible.

Seiffert (1934) suggested an ingenious endoscopic method, but had had no opportunity to carry it out. He proposed to insert, through a bronchoscope, a catheter to which a small rubber balloon had been attached. This would be passed through the fistula into the esophagus, inflated, and pulled back against the fistula. He then envisaged the insertion of a needle through the upper blind sac, keeping close to the trachea, until the balloon was punctured. He could then incise or electro-

coagulate along the needle until he entered the esophagus. A catheter could now be passed through the upper blind sac down into the stomach, and the tracheoesophageal fistula could be closed by application of silver nitrate.

Obstruction Without Tracheoesophageal Fistula.—Complete atresia of the esophagus without tracheoesophageal fistula is an uncommon anomaly (Vinson, 1925), but it should be treated successfully by gastrostomy and cervical esophagostomy if the infants are operated upon early enough. Nevertheless, in the cases reported, the infants have died (Hirsch, 1921; Reynolds and Morrison, 1921; Vinson, 1923; Unger and Poppel, 1938). If recovery should occur, some variety of antethoracic esophagoplasty might later establish the normal swallowing function.

Membranous diaphragms (Mosher, 1911; Abel, 1928; Eckerström, 1932), webs and folds (Sunde, 1937), and the tubular atresias through which there is at least a narrow channel are managed successfully by rupturing the webs or by dilating through an esophagoscope (e.g., Mosher, 1917; Morse, 1920; Vinson, 1923; Beatty, 1928; Harpprecht, 1934). The chief problem of the endoscopist is to get a catheter or string through the stricture. Occasionally it is necessary to make a gastrostomy for retrograde bougienage or to find a minute lumen which may not be visible from above. The use of a ureteral catheter to pass a narrow congenital stricture from below is described by Fitzgibbon (1926) and Simpson (1933). Dilatations by any one of several methods, repeated over a period of months or years, may then lead to normal or near normal passage of food and saliva. Some authors believe electrolysis improves the results of dilatation in some cases (Guisez, 1920; Abel, 1928; Demel, 1933). Simpson, in a 2-day-old infant, treated a case of stenosis of the cardia by gastrostomy followed by retrograde dilatations with an improvised Plummer bag.

Strauss and Hess (1925) were more radical in the management of three patients under 3 years of age who had partial congenital stenosis of the esophagus immediately above the cardiac orifice. They opened the stomach, attached forceps to a catheter which had been passed down through the mouth, pulled the forceps into the stricture, then cut down on them to the mucosa, in the manner of the Ramstedt operation for congenital pyloric stenosis. Two of the babies lived. They believed the operation to be safer and more satisfactory than dilatation by endoscopic means for congenital strictures in this lowermost portion of the esophagus. In a girl, aged 17 years, with congenital stenosis, Petersen (1921) obtained an excellent functional result by constructing an antethoracic esophagus of the Lexer (1911) type. This was an esophagodermatojejunogastrostomy.

Austin and Vinson (1933) reported the case of a farm hand, aged 23 years, afflicted with congenital stenosis, whose jaws and teeth had developed normally on a diet consisting largely of milk, cocoa, and cream

of wheat. The other members of the family, who had eaten ordinary food, had carious and infected teeth. The point was made that in this case mastication of solid food had not been essential for the normal rugged development of the jaws and teeth. The general nutrition was excellent.

The Congenitally Short Esophagus.—Since Richard Bright's description (1836) of the post-mortem findings in a case of congenitally short esophagus and Bailey's interpretation of the anomaly on an embryological basis (1919), a number of reports of this interesting condition have appeared. Often the finding has been incidental, in cadavers (Blasingame, 1936), or at autopsy, or when roentgenologic studies have been made for unrelated conditions; sometimes in elderly individuals who have never had dysphagia, as in one of my cases. Some patients have had symptoms directly related to obstruction in the esophagus. A man, aged 63 years (Weaver and Moersch, 1938), had been troubled for twenty or thirty years by epigastric burning, gaseous eructations, and heartburn, relieved by taking soda. During eighteen months there had been increasing dysphagia and loss of 33 pounds in weight. An x-ray diagnosis of carcinoma of the esophagus was made, but a large mass containing persimmon skins was removed through an esophagoscope. The persimmon ball had formed at a point of narrowing and superficial ulceration where the congenitally short esophagus joined the intrathoracic portion of the stomach. The patient recalled having eaten the persimmons shortly before the onset of symptoms of obstruction. Ross (1934) ascribed the distress in his patient, at least in part, to distention of the portion of the stomach which lay above the diaphragm. Ulceration and bleeding have occurred in the lowermost part of the esophagus or in the intrathoracic portion of the stomach.

Clerf and Manges (1934) state that previous to the illuminating report of Findlay and Kelly (1931), congenital short esophagus was confused with acquired stricture, simple ulceration with cicatricial narrowing, or with narrowing secondary to herniation of the stomach through the diaphragmatic hiatus. The case reported by Eschelman (1923) as congenital stenosis of the esophagus in all probability was of this nature. Most of the cases are accompanied by narrowing of the esophagus at or just above the high esophagogastric junction. This is true whether or not there are symptoms referable to the anomaly. Nonulcerated cases are satisfactorily managed by thorough mastication of food and occasional esophagoscopic dilatations. Ulcerative cases with pain are difficult to treat, although a gastric diet with alkalies and bismuth subnitrate by mouth, or the application of 10 per cent silver nitrate to the ulcer, or careful esophagoscopic dilatation may help. Gastrostomy and prolonged rest of the esophagus may be necessary. Interesting cases are recorded by Kelly (1930), Monkhouse and Montgomery (1933), and Dunhill (1934). The narrowed channel and the

intrathoracic portion of the stomach immediately below it are best visualized by fluoroscopy in the head-down, supine, right anterior oblique position. The barium must be swallowed with the patient inverted. A definite diagnosis is made only by removing a bit of gastric mucous membrane just below the point of narrowing, through an esophagoscope. This is usually at the level of the seventh dorsal vertebra (Findlay and Kelly; Monkhouse and Montgomery; Marks, 1937). In Schilling's case (1932), in a 75-year-old laborer, the condition was associated with a double aortic arch, the larger branch of which lay posterior to the trachea and esophagus.

Other Congenital Defects.—Mucchi (1935) recorded a rare congenital anomaly in which a right aortic arch occurred posterior to the esophagus.

Sauerbruch and Fick (1931) successfully removed an embryonic cyst of the esophagus which had caused serious dysphagia, dyspnea, and palpitation of the heart in an undersized, poorly nourished boy 13 years of age. A plum-sized mass was found on the anterior wall of the esophagus, about 5 cm. above the cardia. This was excised without opening the esophagus. Recovery was complete, symptomatically and roentgenologically, although convalescence was complicated by empyema.

Kirklin's (1932) demonstration, by roentgenography, of an instance of unusual prolongation of the esophagus below the diaphragm, emphasizes the fact that there may be considerable variation (Bársony and Koppenstein, 1935) in the length of the intra-abdominal portion. Kirklin assumed a congenital anomaly in his case. Herzberg (1934) pointed out that the angle of entrance of the esophagus into the stomach may vary greatly.

ACHALASIA OF THE CARDIA

The work of Hurst (1925, 1934), Rake (1926, 1927), and Cameron (1927), focused attention on degeneration of Auerbach's plexus as the underlying pathologic change in practically all cases of so-called "idiopathic dilatation," "cardiospasm," "phrenospasm," or "achalasia of the cardia." Their work has been quite generally accepted (e.g., Beattie, 1931; Scrimger, 1931; Etzel, 1934), although in Wright and Freeman's case (1934), Auerbach's plexus was said to be normal. As a rule, the vagus trunks are unaffected (see Ewald, 1907; Zaaijer, 1920; Etzel, 1934; and, for a well-known exception, Kraus, 1902).

The cause of the degeneration in the fibers and ganglion cells of Auerbach's plexus is not entirely clear. Partly on the basis of experimental work and partly as a result of clinical and post-mortem observations, Etzel (1935, 1937) came to the conclusion that this degeneration is due to a chronic deficiency in vitamin B_1. The occasional coincidence of megacolon (Bignami, 1931; Ledoux-Lebard, Nemours-Auguste and Lefebvre, 1936; Martini and Comas, 1937), in which regional degeneration of Auerbach's plexus is also present (Etzel, 1934, 1935, 1937), provides additional evidence of a generalized nutritional origin in achalasia.

It has been suggested (Womack, 1938) that the vitamin deficiency may be secondary, rather than primary, but nevertheless Etzel's observations are of the greatest interest.

Mosher (1930, 1931, 1933, 1935) believes that the original process which leads to achalasia is a diffuse inflammatory infiltration which arises in the mucosa of the esophagus locally, or as part of a generalized infection, or as an extension from neighboring tissues or organs. Such a process might lead to destruction of Auerbach's plexus and the clinical picture of achalasia or to stricture on a fibrotic basis. Miller (1930) reported success in treating two cases of achalasia only after removing foci of infection. In the case of Messeloff, Shulman, and Buckstein (1928), in an 11-year-old girl the symptoms were of only two months' duration and followed closely an attack of whooping cough. The symptoms in a child seen by Nyström (1930) followed diphtheria. Campián (1931) recorded a case of achalasia in a tabetic.

Carlson, Boyd, and Pearcy (1922) confirmed and extended Openchowski's observations on the reflex control of the cardia and lower esophagus, thereby laying the groundwork for the possibility that clinical "cardiospasm" in some cases may be caused reflexly by distant lesions, such as disease of the gall bladder.

Bohrer (1934), in searching for the explanation of the immediate relief, following dilatation, of symptoms in a female infant, 19 months old, asked if there may not be an unrecognized fissure or ulcer in these cases. It is interesting to recall that Mikulicz (1904) compared his method of dilatation of the cardia (with a clamp or the fingers) to dilatation of the rectum for fissure-in-ano. However, in view of the fact that there is no characteristic pain in most cases, and, inasmuch as Rake and others have demonstrated the degenerative changes in Auerbach's plexus, the presence of a fissure or ulcer as the cause of a retention spasm does not seem very likely.*

*Spasm arising in the portion of the esophagus between the cricopharyngeus and the cardia without any intrinsic esophageal lesion is described as simple nonsphincteric spasm of the esophagus by McGibbon and Mather (1937). The diagnosis is a dangerous one without the most careful investigation, as spasm of the esophagus is common in association with graver lesions. Simple nonsphincteric spasm may be localized or diffuse; it may be transient, intermittent, or persistent in character. The radiological appearances are typical, and as a rule esophagoscopy is negative. It is a neurogenic manifestation and may be followed by achalasia. As a rule, this type of spasm is secondary to disease or an altered state of other organs, and, if it does not resolve spontaneously, satisfactory relief can only be obtained by treating the primary lesion. The similarity of the pain in these cases to that of angina pectoris is mentioned by Moersch and Camp (1934). D. E. Jackson and H. L. Jackson (1936) believe that alterations in esophageal and gastric tone (distention and shortening) are the cause of angina pectoris. Expressed in another way, these authors state that in their opinion "angina pectoris is due to acute, spasmodic, incoordinated contractions of the esophagus and stomach." They explain sudden death in this disease on the basis of reflex inhibition of the heart, due to gas or food entrapped under pressure in the esophagus. They note that the acute symptoms often may be relieved by passing a stomach tube. As might be expected, the pain of diaphragmatic hernia is often similar. An interesting study of direct splanchnic and referred pain from the esophagus is to be found in the publication of Stürup (1937). Moore (1930) and Pepper (1937) noted that pain originating from disorders of the esophagus is often mistaken for pain of cardiac origin. Polland and Bloomfield (1931) advanced evidence that the symptoms of patients with epigastric distress associated with peptic ulcer of the stomach or duodenum may be due to reflex spasm of the esophagus. In some patients, a distended balloon within the esophagus reproduced "heartburn" even though no acid was present, agreeing with the clinical

(*Cont'd bottom of next page.*)

A fairly large number of cases of achalasia have been seen in infants and children. Among recent interesting cases may be mentioned those of Rebattu and Mayoux (1925) in a boy, 12 years of age, who had had symptoms from the time of weaning; of Häggström (1930) in a male, aged 30 years, whose symptoms began in childhood; and of Boppe (1935) in a boy 13 years of age, whose dysphagia of twelve years' standing was relieved by a Heller extramucous esophagotomy. Phelps (1930) reported three cases in infants, all improved by bougienage. It is natural to label these congenital (e.g., Gonzalez, 1933), but possible factors, such as intrauterine or post-partem infections, or vitamin deficiencies, should not be lost sight of. Van Gilse (1928) suggested as the cause of the dilated esophagus in his small patient a birth injury with damage to the vagus centers. Gerlings (1936) noted that in interpreting the fluoroscopic appearances it is necessary to recognize that in infants the esophagus is normally relatively large and there is much aerophagia (see also, Aimé, 1937). When solid food is taken on weaning, the condition usually disappears. Gerlings thinks the infantile state may persist in some cases as "congenital spasm of the lower esophagus."†

Experiments have shown that in dogs complete division of one vagus nerve and partial destruction of the other result in a condition which simulates achalasia (e.g., Ozorio de Almeida, 1929; de Vasconcellos, 1934). The vagus impulses apparently (1) increase tone and peristalsis in the esophagus, and (2) elevate and enlarge the cardiac orifice by contracting the outer, longitudinal muscle coats (see von Mikulicz, 1903; Scrimger, 1931). When Auerbach's plexus is partly or wholly destroyed, the esophagus becomes irregularly active and later quiet, and

observation of "heartburn" in patients with achlorhydria. Vinson (1925) stated that esophageal obstruction, especially cardiospasm, should always be suspected when there is epigastric pain which suggests gallstone colic or angina pectoris. On the other hand, this type of pain just as well may be caused by spasm secondary to ulceration of the esophagus (Barclay, 1915; Connolly, 1934).

Wallis (1934) described a case of functional spasm of the upper esophagus in an infant during the first year of life. Carlson (1922) gave an account of temporary local spasm with dysphagia in a laboratory worker whose pharyngeal and esophageal mucosal membranes were burned with sodium hydroxide. Friedrich (1934) described an instance of diffuse esophageal spasm due apparently to compression of the ninth and tenth cranial nerves and the medulla by advancing osteitis fibrosa at the base of the skull. McGibbon (1935) and others have reported cases of dysphagia with anemia which should be kept in mind when no organic cause for the distressing symptoms can be found. The syndrome, which occurs as a rule in young women, is said to be due to a deficiency of vitamin B_1, and responds readily to dilatation of the esophageal entrance and the administration of large doses of iron and a well-balanced diet.

†These young patients, and occasionally older ones, sometimes exhibit esophageal changes which seem to be due to improper functioning of the vagus fibers, but which do not fit into the usual picture of achalasia. Kelly (1935), in 100 consecutive autopsies on infants and young children, found in three male subjects great dilatation and atrophy of the musculature of the esophagus below the level of the trachea. The cardia, instead of being obstructed, was unusually wide open. The stomach was thin and smooth. In a later article (1936) he reproduced drawings from these most striking cases of fatal malfunction. Negus (1936) found a similar condition in an infant, aged 6 weeks, the cause of which he could not determine; the cells of Auerbach's plexus did not appear to be degenerated. Abell (1930) reported a possibly similar condition in a woman, aged 62 years, whose gastric contents flowed freely into the greatly dilated esophagus whenever she lay down, but which, when she stood up, emptied into the stomach again. At operation, Abell narrowed the diaphragmatic hiatus so that it admitted only the tip of the index finger. The symptoms were relieved for five years.

the cardia fails to open normally in response to an oncoming bolus of food (e.g., Tamiya, 1929; Tamiya and Tamura, 1931). The role of the sympathetic fibers is not entirely clear, but it seems likely that in general they regulate the activities of the vagus and that they are responsible for the tone of the circular and oblique smooth muscle fibers in the region of the cardia (Ohsawa, 1933).

Other factors which have been brought forward as of etiologic importance in achalasia may be secondary; for example, overaction, faulty action, or position of the diaphragm. Jackson, in his books (1907, et seq.), Bassler (1914), Joannides (1929), Peroni (1937), and a few others speak of phrenospasm as a possible cause of the disease. It should be noted that Jackson does not exclude other possible causes, but he believes the disease as a rule to be "simply the failure of the diaphragmatic pinchcock to open normally in the deglutitory cycle." MacLeod (1937) reported a case in which a high left diaphragm, which apparently was elevated by distention of the colon and fundus of the stomach, seemed to distort the lower esophagus enough to cause partial esophageal retention. Graham, Singer, and Ballon (1935) reproduced the film of a patient who developed typical "cardiospasm" two months following left phrenicectomy for bronchiectasis. The significance of this unusual observation (Balloon, Wilson, Singer, and Graham, 1930), is not clear, but, at any rate, phrenospasm can scarcely have been the cause of the condition. Furthermore, it is well known that paralyzing the phrenic nerve does not relieve achalasia. On the contrary, in the case of semisolid and solid foods, the emptying of the esophagus is aided normally by the milking action of the crura of the diaphragm (Fulde, 1934). Most observers (e.g., Bársony and Wald, 1938) agree that in achalasia the initial obstruction is below the level of the crura of the diaphragm. If the vagus fails, because of damage to Auerbach's plexus, the oncoming food collects in a somewhat atonic esophagus, and the cardia, possessed of its normal tone, does not open, even though the diaphragm is active. Later on, the diaphragm may be of considerable importance in aggravating the condition because, if the disease has progressed sufficiently, the dilated esophagus hangs over its sharp edge, in this way forming a dependent undrained sac which by hydrostatic pressure distorts and collapses the channel into the stomach. Mosher (1927) concluded that the pressure of the expanding lung tips and the obliquity of the hiatal portion of the esophagus have much to do with irregularities of emptying. In the worst cases the esophagus may become tortuous and S-shaped and the lowest loop may hang far below the diaphragmatic hiatus and cardia (Heyrovsky, 1912; Lambert, 1914; Scrimger, 1931). Naturally, in such a case the secondary mechanical factors, distortion and gravity, far outstrip the original achalasia as elements of importance in the obstruction. Any treatment which fails to take them into consideration is futile.

Much of the edema, fibrosis, and ulceration which occurs in achalasia results from obstruction, stasis, and putrefaction (e.g., E. E. Graham, 1919; Charbonnel and Massé, 1932). The diverticula which not infrequently form in cases of achalasia may be the result of stasis, although it is just as reasonable to say that the diverticula were present first and caused the spasm of the cardia reflexly (see Fitzgibbon, 1928).

A considerable number of reports have appeared from time to time which encourage the use of drugs in the diagnosis and therapy of various spastic and atonic states of the esophagus, including achalasia. Papaverine hydrochloride, which acts directly on smooth muscle to diminish its tone, appears to have a favorable effect in some early cases of achalasia (Stein, 1915). In a case of "cardiospasm" Howarth (1922) stated that 4 gr. of papaverine injected subcutaneously caused almost immediate relaxation of the cardia and the whole bismuth meal was in the stomach within five minutes. Doumer and Cuvelier (1937) found this drug, given by mouth, one-fourth hour a.c., t.i.d., 20 drops of 2 per cent solution, undiluted, very effective for relief of spasm in achalasia, ulcer, or carcinoma. On the other hand, Tamiya, Kawashima, Inada, and Fuzimura (1929) stated that in two of their patients the dilated esophagus did not empty after papaverine alone, even though the peristalsis increased and the tone of the lower esophagus and cardia decreased. Only if adrenalin or a sequence of papaverine-adrenalin were used did the barium pass into the stomach with certainty. If adrenalin was injected first, papaverine failed to empty the esophagus. Guns (1928) found that in normal human beings atropine produces spasm in the region of the cardia. Atropine and belladonna appear to be of no use in achalasia, although they are often beneficial in spasm of the esophagus at higher levels.

The experiences of Canfield (1937) are worth noting. In two cases of achalasia complicated by very serious esophagitis the inflammation was gradually improved by washing the esophagus out daily for an extended period. In both cases dilatation was eventually carried out safely, with complete relief of all symptoms. Bull (1925) and others have emphasized the importance of thorough cleansing of the esophagus before any operation for achalasia, or, for that matter, before any operation on the gullet.

In America, surgical relief for intractable achalasia has been resorted to less often than in Europe. It should be noted, also, that even in Germany Lotheissen (1934), in an extensive experience covering a period of many years, has never found operative methods necessary, although he remarks that if he did not succeed by dilatation in a case he would use them. Possibly the results obtained by repeated dilatations have been better on the average here than abroad (Plummer, 1912; Smithies, 1930; Nagel, 1936, 1938). It is quite certain, though, that a fairly large number of chronic invalids, perhaps one to three in every

large city, deserve further treatment by operation. These patients, with large, dependent esophageal sacs, usually have been dilated without permanent relief, and, as noted previously, the mechanical situation is such that little could be expected except by operation. The Mikulicz (1904) method of dilatation with the fingers or an instrument, introduced from the stomach, is ineffective except in uncomplicated cases in which endoscopic dilatation by a bag would do just as well. Wendel's (1910) open esophagoplasty, and Heller's (1913) extramucous esophagocardioplasty, when used in the advanced cases, can only be successful if the redundant esophagus is straightened out by pulling its sagging lower portion from the thorax into the abdomen.

The Heller operation still has many advocates, especially in Southern Europe (e.g., Delbet, 1929; Oberthur, 1931; Iacobovici and Hanganut, 1931; Charbonnel and Massé, 1932; Soupault and Hamburger, 1933; Pieri, 1933; Desplas and Camelot, 1937). Zaaijer (1929) had no deaths following eight Heller operations, and Rieder (1931) none in six. In 1933, Ohsawa reported 6 successful Heller operations by the transthoracic route; there were no failures. Very few late reports are available on these operations, but the emphasis which some authors (Fruchaud, 1934; Desplas and Aimé, 1936) placed on the necessity for making a very long extramucous incision indicates that there have been unsatisfactory results. Charbonnel and Massé note that Delbet's patient required a second operation. In a few cases cicatrization has occurred, narrowing the lower esophagus and necessitating esophagogastrostomy (e.g., Küss, 1936). Two of Turner's patients (1931), operated upon by the Heller technique, had recurrences and one of these was subsequently cured by an open cardioplasty of the Heineke-Mikulicz type. Knight (1936) was disappointed in the results of two Heller operations. Scrimger (1931) recorded a successful result by this method, but another patient died of mediastinitis following inadvertent perforation of the mucosa. Thereafter, in three cases Scrimger simply freed the esophagus, brought it down and straightened it out, and cut the crura, as first suggested by Bassler (1914) and subsequently practiced by Charbonnel and Massé. The results were good and he believes the extramucous esophagocardioplasty portion of the Heller operation is not essential. Turner (1931) operated upon five patients by the method of the French surgeons (Tuffier, 1922; Hartmann, 1929), loosening the esophagus and bringing it down without incising the muscular layer, and only one patient obtained anything like permanent relief, but it should be noted that he did not divide the crura of the diaphragm.

The operation which has found most favor in Europe has been Heyrovsky's (1912) esophagogastrostomy by the abdominal route. Fromme (1929) said that it carries a negligible mortality. Häggström's (1930) collected statistics are of great interest: Heyrovsky's

operation had been done in twenty-nine cases by thirteen operators, with no deaths and with good functional results in all. According to Häggström, the same operation when done by the thoracic route had resulted fatally in two of 5 cases; an additional patient developed empyema postoperatively but recovered. In another patient, operated upon by the transthoracic route (Breitner, 1930), adhesions were dense and the exposure imperfect. The patient recovered from a localized empyema, but the functional result of the anastomosis was poor. The author thought that the abdominal approach would have been more favorable. On the other hand, von Haberer (1930) was unable to complete an Heyrovsky operation by the abdominal route. At a later left-sided thoracotomy, it was seen that the dilatation began a hand's breadth above the diaphragm. A successful esophagogastrostomy was performed. Naegeli (1930) referred to a fatal transthoracic esophagogastrostomy. Six Heyrovsky esophagogastrostomies via the abdomen were performed successfully by Turner (1936), although one patient required a secondary operation because of closure of the stoma; in the same article, Knight reported three more satisfactory esophagogastrostomies; another favorable case was referred to by Nehrkorn (1930).

It is plain that, when an esophagogastrostomy is done by the abdominal route, the operator of necessity must enlarge the hiatus, mobilize the redundant lower esophagus, and bring it well below the diaphragm, before he can make an anastomosis easily and safely. In this way the esophagus is automatically straightened and the crura may be divided. Much of the success of this operation is undoubtedly due to these factors. In a few instances reference is made to the necessity of making a large anastomosis and to the importance of leaving no spur behind which esophageal contents can stagnate. Such cautioning statements always indicate imperfect functioning which the author thinks can be improved upon.

In the operation by Lambert (1914) the redundant esophagus was brought down into the abdomen and sewed all around to the diaphragm. Through a gastrostomy opening, a long clamp was partly closed with one blade in the esophagus and the other in the stomach. The handles were brought out of the wound and gradually approximated. The clamp sloughed through on the ninth postoperative day. An x-ray study, four months later, showed that the esophagus emptied well and was much smaller. Lambert's operation resulted in a sort of "Finney pyloroplasty," which provides a large anastomosis without a spur. This same effect was obtained by Frey (1932, 1938), who, by a transthoracic approach, freed the greater curvature of the stomach and sutured a broad surface of fundus against the anterior half of the dilated lower esophagus without tension. He then opened the anterior wall of the stomach, divided the broad spur he had fashioned, and sewed it all around from the inside, in this way completing a "Finney pyloroplasty" in another

way. The anterior wall of the stomach was closed and the anastomosis was placed below the diaphragm. No drainage was used; fluid did not accumulate in the pleural cavity, and the result was excellent.

Gröndahl (1916), Bull (1925), Scandinavian surgeons, and Watts (1923), of Virginia, performed abdominal cardioplasties by a technique similar to Finney's for the pylorus. Bull emphasized the importance of widening the hiatus by severing the pillars of the diaphragm and of straightening the esophagus out and bringing the lower portion into the abdomen, where it was sutured to the diaphragm. The anastomosis was then done below the diaphragm, using a U-shaped incision which made a wide opening without a spur, and was very satisfactory. Four operations of this kind have been reported in this country, two by Churchill (1935) and two by Womack (1938). On the whole, this procedure appears to be safe and gives the best results of any proposed.

Except in patients of the extreme dolichomorphous type, the abdominal approach for operations at the cardia is not particularly difficult for surgeons who are accustomed to work high in the upper abdomen (see Herzberg, 1934). Only rarely is it necessary to mobilize the seventh, eighth, and ninth cartilages on the left (see Marwedel, 1903, and description of Ohsawa's technique later in article). Usually a midline incision from the ensiform to the umbilicus and mobilization of the left lobe of the liver by dividing the coronary ligament (Lambert, 1914) give adequate room in which to work. The redundant esophagus can easily be brought into the abdomen. Sauerbruch and his pupils (see Krauss, 1933) are the strongest advocates of the transthoracic operation. Grégoire (1932) and Braine (1932) have used an extrapleural, extraperitoneal approach extensively and with satisfaction: a U-shaped incision is begun paravertebrally over the left eighth rib, curved downward to the twelfth rib, and back up to the eighth in the posterior axillary line, resecting the twelfth rib, dividing the eleventh anteriorly and posteriorly, and the tenth and ninth posteriorly only. By dissecting extrapleurally and extraperitoneally, excellent exposure is obtained of the lower esophagus, diaphragm, and cardia, according to the authors. Braine reported six successes and no failures with Heller's operation, using this exposure.

Another type of operation which at first thought seems promising aims to interrupt the sympathetic impulses which flow to the region of the cardia. If sympathetic innervation is responsible for normal tone at the cardia, division of the sympathetic fibers might relieve obstruction in achalasia by paralyzing the constricting muscle there. In 1934, Craig, Moersch, and Vinson successfully treated a patient with intractable cardiospasm, accompanied by pain in the left chest, shoulder, and arm, by bilateral cervicothoracic sympathetic ganglionectomy. As a result of their experiments on cats, Knight and Adamson (1935) became convinced that denervation by excising the left gastric artery and the im-

mediately adjacent omental tissues running up to the base of the esophagus should remove the sympathetic control of the cardia and cure achalasia. In their cats, bilateral vagus excision resulted in achalasia, but, if the thoracic sympathetic chains were removed at the same time bilaterally, no obstruction occurred. They reasoned, therefore, that the activity of the sympathetic fibers is essential for obstruction. In the cats, after production of achalasia by bilateral excision of the vagi, a celiac sympathetectomy gave complete relief from the obstruction, as shown by fluoroscopic studies. Eight patients with achalasia were operated upon similarly (four of these by Adamson), but the results were not very good (Turner and Knight, 1936). Two patients of Souttar's (1935) were benefited by the operation. Stubbe (1937) also reported an improvement; the esophagus was still dilated ten months after operation, but barium entered the stomach freely. It is interesting to note that sympathetic denervation, as carried out by Adamson and Knight, does not result in regurgitation from the stomach into the esophagus.

Carlson, Boyd, and Pearcy (1922) and Caballero (1923) demonstrated in dogs and cats a motor and inhibitory innervation of the cardia and lower esophagus via the splanchnic nerves (see also Fulde, 1934). This was further substantiated by Woollard (1935), but he warns the surgeon against expecting clean-cut results from surgery in this field. His anatomic studies, extended by Mitchell (1938), show that sympathetic fibers may reach the esophagus in at least three ways: (1) from above, having entered the vagi from the cervical sympathetic chain; (2) from the inferior cervical and thoracic sympathetic ganglia (only a few fibers); (3) from the celiac plexus, from which fibers may travel in company with the left gastric artery to the region of the cardia. From the work of these authors, it seems unlikely that any operation of reasonable magnitude will effectively remove the sympathetic supply to the cardia. Furthermore, it seems doubtful to me that denervation would benefit patients with advanced degrees of the disease in which the mechanical factors are prominent; whereas, in the early cases endoscopic dilatations are more easily carried out and are at least as effective.

On the basis of experiments on dogs, de Francesco (1934) concluded that, by injecting alcohol locally or by interrupting all of the nerves by stripping off the longitudinal muscle layer, he could produce a loss of tone and peristalsis of the lower esophagus, and also, temporarily, of the cardia. Recalde (1932) cured three out of four patients operated upon by stripping away the longitudinal muscle layer; the other patient died of subphrenic abscess, the result of perforation of the mucosa at operation. Mitchell (1938) is of the opinion that the improvement in Recalde's patients may be due to mechanical rather than neurological effects.

The importance of the differentiation of achalasia from carcinoma, cicatricial stricture, impacted foreign body, epicardial diverticulum, and hiatus hernia is discussed by Mikulicz (1904), Plummer (1912), Vinson (1923, 1936, 1938), Vinson and Moersch (1928, 1935), and Roessler (1935).

DIVERTICULA

Pharyngeal diverticula are not, of course, esophageal lesions, but the sacs hang down against the esophagus and for practical purposes may be considered as such. They outnumber true esophageal diverticula, but nevertheless are comparatively rare. These pouches are hernias of the lower pharyngeal mucosa which protrude, usually in elderly males, through a weak spot between the muscle fibers, usually in the midline, immediately above the cricopharyngeus muscle (Moynihan, 1932; Lerche, 1936).

Credit for the reduction, almost to the vanishing point, of the mortality rate following surgical removal of these sacs must be ascribed to the special interest shown by American surgeons (Mayo, 1910; Murphy, 1916; Judd, 1918; Judd and Phillips, 1934; Lahey, 1933, 1937; Lahey and Hoover, 1937; Gaub and Jackson, 1915; Torek, 1921; Eliason, 1923; Babcock and Jackson, 1931, 1936; Perrone, 1936; Eliason, Tucker, and Thigpen, 1937), but the very important contribution of the two-stage operation was made by the German, Goldmann (1909). The danger of mediastinitis, originally a serious hazard following the one-stage operation, is no longer great for those who are patient enough to carry out a specialized technique with nicety. However, for maximum safety to the patient in any case, and for the occasional operator in this field in all instances, the two-stage procedure is advisable.

Careful roentgenologic and esophagoscopic studies are indispensable before operation. In several instances of carcinoma an erroneous diagnosis of pharyngeal diverticulum has been made (Clerf, 1932). Carcinoma has been discovered in the sac of a pharyngeal pouch (Raven, 1933).

The elderly patients are often in a state of poor nutrition. Vinson (1925) advised against preliminary gastrostomy, but said that by a suitable technique a silk thread can always be passed, after which a catheter may be guided into the stomach for preoperative feedings. Local anesthesia is all that is necessary (Sturgeon, 1929). A catheter in the esophagus helps lead the operator to the sac. A bougie (Kingman, 1923) or an esophagoscope (Gaub and Jackson, 1915) within the sac itself is a still better guide. Whether a one- or two-stage operation is used, it is very important to dissect the pouch out completely so that a residual pocket will not be left. It is equally important not to narrow the lumen of the esophagus by excising a portion of the normal wall. A stomach tube (Metheny, 1935) or esophagoscope in the esophagus at the time of removal is of assistance in preventing this. For about ten

days after operation, patients should be fed by a tube passed through the nose into the stomach (Krekel, 1923; Crile and Dinsmore, 1924). If there is tendency toward spasm or stenosis, postoperative dilatations should be carried out at intervals for a year or more. Lahey (1933 1937) found this quite often necessary following his two-stage operations; whereas, Jackson and Jackson (1933), and Eliason, Tucker, and Thigpen (1937) reported no obstructive symptoms after the one-stage operation aided by the esophagoscope.

For patients in whom operation is refused or contraindicated, Moersch and Judd (1934) advised the periodic passage of sounds, a thread always being used as a guide. For patients who are not good subjects for a complete operation, the expedient of Liebl (1910), Schmid (1912), and König (1922) of freeing the sac and fixing it in a cephalad direction so that it will drain may be used. Recurrence is common after this operation (see Jackson and Jackson, 1933), but a few symptomatic cures have been obtained in a very safe manner (e.g., Schwarz, 1935). For small pharyngeal diverticula, Lotheissen (1931) used Girard's (1896) method of progressive infolding of the sac with two or three purse-string sutures, followed by a transverse row and the suturing of the stump against the thyroid gland (see also Bevan, 1917, 1921). Inversion of the sac into the pharynx, with or without the removal of the sac transorally with a snare (McClure, 1934; Ross, 1937), may lead to serious consequences from laryngeal obstruction.

Oehlecker (1937) reported an unusually large pharyngeal diverticulum in a male, aged 70 years, who had had dysphagia for twenty years. At the first operation, the neck of the diverticulum was divided, the pharynx closed, and the sac drained by a tube in the right supraclavicular fossa. Because of the foul discharge, the pouch was later partially removed through a right posterior mediastinal approach. At a third operation, the remainder of the sac was excised, but pneumonia resulted in death.

Guisez (1925) and others have expressed the opinion that most diverticula of the midesophagus arise as the result of contraction of adjacent scar tissue, usually tuberculous. He saw one case in the upper third which resulted from a bullet wound; as the sinus cicatrized, a diverticulum formed. Herzog (1933) presented two examples in which traction diverticula were seen to arise following roentgen therapy for intrathoracic tumors. He explained them on the basis of regression of exudative inflammation about the esophagus, with resulting traction on the walls by scar tissue.

Wallace (1937), in a study of twenty-six cases of traction diverticulum of the midesophagus, found that more than one-third of the patients had symptoms (pain in six, dysphagia in six, hematemesis in three). Some of the smallest sacs caused trouble and some of the largest, none. Most authors (e.g., Heacock, 1930; Herskovits, 1938; Sturtevant, Sha-

piro, and Wallace, 1932) are under the impression that symptoms are usually absent in this lesion. Sturtevant, Shapiro, and Wallace and Lotheissen (1931) emphasize the occasional occurrence of complications, such as cancer or perforation with mediastinitis or pulmonary gangrene.

Guisez (1925), Jackson and Jackson (1933), and Macmillan (1935) ascribed pulsion diverticula of the lower esophagus to the effects of increased esophageal pressure secondary to obstruction lower down, as from achalasia, congenital webs, or inflammatory stenosis. Elward (1936) reported a case in a patient with an hiatus hernia. The association of diverticulum with achalasia, and the possible interdependence, was pointed out by Hurst (1925), M. K. Smith (1928), and Lotheissen (1931). On the other hand, L. A. Smith (1928) found among nine patients with diverticula of the thoracic esophagus only one in whom there was any evidence of achalasia. Schmidt (1936) considered several small diverticula found incidentally at autopsy in a boy, aged 7 years, to be congenital in origin. Lerche (1936) believes that diverticula usually arise in certain areas along the wall of the esophagus where the imbrications of muscle fibers are thinnest, in this way affording diminished resistance to increased intraesophageal pressure.

When diverticula arise immediately above the diaphragm, diagnosis may not be immediately apparent, and even following roentgenographic and esophagoscopic studies there may be confusion with hiatus hernia or congenitally short esophagus (Marks, 1937). Haenisch (1923) found in his case that a stomach tube always curled up in the right-sided sac; whereas, in every instance of right-sided hiatus hernia which he had seen, a tube passed readily into the portion of the stomach below the diaphragm.

When diverticula occur in association with achalasia or other obstructive lesions, instrumental dilatation of the esophagus will often relieve all symptoms (Hurst, 1925; M. K. Smith, 1928; Jackson and Jackson, 1933; Nissen, 1934), but if difficulties persist surgical intervention is occasionally justified. On the basis of experimental work, Gosset (1903) and Lotheissen (1908) suggested that the distress which accompanies large epiphrenic diverticula might be relieved by transdiaphragmatic anastomosis of the sac with the fundus of the stomach. According to Heyrovsky (1912), this was actually done by Lotheissen, but I was unable to find the account. Lotheissen (1931) referred briefly to his case and also noted that esophagogastrostomies, supposedly for diverticula, were carried out by Sauerbruch and Henschen. Von Hacker and Lotheissen (1926) noted the successful removal by Willy Meyer of a sac from the lower portion of the esophagus. Clairmont (1924) excised a hen's-egg-sized epiphrenic diverticulum in a woman, aged 43 years. The sac and adjacent esophagus were displaced into the peritoneal cavity, the pouch removed, and the defect sutured in layers, with recovery. Sauerbruch (1927) reported three successful cases:

(1) a diverticulum of the lower esophagus, the size of two adult fists, in a male, aged 51 years, removed in two stages by anterior mediastinotomy; (2) a perforated traction diverticulum, removed by way of a posterior mediastinotomy following the drainage of an abscess of the lung, which it had caused, in a female, aged 27 years; (3) a large epiphrenic diverticulum in a woman, aged 48 years, with severe cardiospasm of long standing, excised, the defect closed in two layers, and a flap of paralyzed diaphragm sewed over the suture line. In this case the sac was removed instead of anastomosing it to the stomach because the lower pole could not readily be approximated to the fundus. The symptoms of cardiospasm were completely relieved by the removal of the diverticulum.

Quartero (1931) reported the successful removal by P. A. Vos of a very large diverticulum from a male, aged 40 years, who had suffered from dysphagia since the age of 5. The immense sac lay against the dome of the diaphragm. Because of its position on the right, it was impossible to unite it with the stomach. The resection was carried out by removing the tenth and eleventh ribs posteriorly. The neck was closed with a double row of sutures. After eight days, a fistula appeared in the wound, but it healed eventually, and 6 months later the patient was well. Barrett (1933) recorded a successful resection by W. H. C. Romanis in a woman, aged 59 years, who for two years had suffered from a sense of fulness in the chest and progressive loss of weight. A large pouch was seen by x-ray, with the neck at the level of the seventh rib posteriorly. A right-sided pneumothorax was given and two days later ether was administered intratracheally. A bougie was passed into the sac and left there as a guide. By a transpleural exposure through the sixth interspace, the sac was found to open by a wide mouth into the right side of the esophagus, above the level of the azygos vein. It was thick and fibrous and stretched vertically downward for 3½ inches along the esophageal wall. After freeing it, the neck was crushed with a Parker-Kerr clamp, divided with a diathermy knife, and closed with two layers of catgut sutures. A small flap of the parietal pleura was cut to cover the suture line and the thorax was closed without drainage, with lungs expanded. Atropine was provided in large doses for forty-eight hours, and the patient was fed through a transnasal gastric tube for nine days. Fluid accumulated temporarily in the right pleural cavity, but was reabsorbed. The patient was well six months later and roentgenography showed a normal esophagus.

By inverting a thumb-sized diverticulum into the lumen at the level of the root of the lung, Turner (1936) attempted to avoid the dangers of opening the esophagus. He used a posterior extrapleural approach, but injured the pleura accidentally and the patient died of a severe septic pneumonia and empyema with a bronchopleural fistula. At autopsy the infolded diverticulum was found to have become only a

prominence. Portis (1921) reported on an epiphrenic diverticulum for which surgical removal seemed indicated. Lahey (1937), carrying out the suggestion of König (1922), approached a troublesome mediastinal diverticulum transpleurally and sutured the liberated sac in an inverted position so that it remained empty. This appears to be a simple, safe, and effective procedure, probably applicable only to small thoracic diverticula.

BENIGN TUMORS

By 1932, according to Patterson, only 61 cases of benign tumor of the esophagus had been reported, of which 26 were polyps, 8 papillomas, 2 fibromas, 2 lipomas, 1 lipomyoma, 8 myomas, 6 leiomyomas, 2 adenomas, 1 hemangioma, 3 epithelial cysts, 1 dermoid cyst, and 1 aberrant thyroid. A rather large number of the growths had been found incidentally at autopsy, but others had caused dysphagia or obstructive dyspnea. Several of them were regurgitated with dramatic results. In Patterson's own case, in a male, aged 54 years, a mass repeatedly came up into the back of the throat, then disappeared. The tumor, a myxofibroma, was found to be attached to the left wall of the esophagus, 2 cm. below the pharynx. The narrow pedicle was severed with some difficulty with forceps. In the case of Garretson and Hardie (1928), a pedunculated fibrolipoma, 15 cm. long and 1.5 cm. in diameter, was vomited up during a Bárány test and was removed with a tonsil snare. The authors remarked that the dragging action of peristalsis tends to elongate such masses. Weyrich (1933) reported an autopsy on a man, aged 58 years, who, without premonitory symptoms, strangulated suddenly. Attached to the wall of the esophagus at the level of the first thoracic vertebra was a lipoma with a narrow neck which extended upward for 9.5 cm. to the entrance of the larynx. Here the swollen, edematous end of the tumor had blocked the airway.* Chitty (1938) presented a Chinese male, aged 26 years, who, during a fit of coughing, expelled a long, fleshy polyp for a distance of seven inches beyond his teeth. The pedicle, attached at the junction of the pharynx and esophagus posteriorly, was severed after opening the esophagus by a cervical incision. Healing was delayed by suppuration, but the outcome was good, without stricture.

Ginsburg (1931) noted that papillomas of the esophagus are usually single and pedunculated; however, in two cases, including his own, they had been multiple. He had removed them, relieving the dysphagia. Hunt (1937) added a similar case of papillomas in a woman, aged 70 years, who because of moderate dysphagia had passed a stomach tube on herself for a period of thirty years. Whether or not the resulting chronic inflammation had an etiologic bearing was questionable.

*A less serious degree of obstruction, of a similar nature, occurred in a case of McClure's (1934) following the inversion at operation of a hypopharyngeal diverticulum.

In reporting two cases of myoma of the esophagus associated with diverticula, Stewart (1931) suggested that mechanical effects due to the presence of the myomas may have caused the diverticula. In an autopsy on a male, aged 74 years, multiple, pea-sized myomas were found at the junction of the upper and middle thirds of the esophagus (Rose, 1936). Moderate obstruction, dilatation and hypertrophy above them, and some hypertrophy below them were thought possibly to be the result of dysfunction of the muscle-nerve mechanism brought about by the presence of the tumors.

Moersch and Broders (1935) reported an adenoma, one of the rarest of the benign tumors of the esophagus, in a male, aged 48 years, who also suffered from a duodenal ulcer. Eleven months after the original observation, no advance was to be seen in the extent of the lesion. The patient did not elect surgical treatment.

Cabot case No. 23491 (1937) records the story of a girl, aged 19 years, who had had pain over the lower sternum for two years and difficulty in swallowing solid foods for 8 months. Roentgenography showed at the level of the fifth to eighth dorsal vertebrae a round, soft tissue mass which seemed attached to the esophagus and pulled it to the right. The mucosal relief, however, appeared normal. At operation, by a right transpleural approach, the tumor was shelled out of the wall of the esophagus without injury to the mucosa. It was a firm, fibrous, perfectly encapsulated fibroma which microscopically presented whorls of cells and palisading, suggesting a neural origin. There were no mitotic figures.

In an autopsy on a patient with cirrhosis of the liver, Carnot, Rachet, and Delafontaine (1929) found in the midst of many venous varices of the lower esophagus a lentil-sized, multilobed, pedunculated arterial nevus. The authors referred to Bouchard, Claude, and Gilbert, all of whom related arterial nevi, especially the cutaneous ones of the trunk, to cirrhosis of the liver. By the application of radium, Guisez (1913) cured an angioma which had almost completely obstructed the lower esophagus in an elderly male. Broders, Vinson, and Davis (1933) described a case of hemangioendothelioma of the esophagus in a female, aged 76 years. She had had dysphagia and substernal pain for six weeks. X-ray and esophagoscopy showed an infiltrating lesion invading the left anterior wall of the lower esophagus.

For benign pedunculated tumors of the esophagus, Lotheissen, as early as 1899, recommended removal through an esophagoscope. Von Hacker and Lotheissen (1926) noted that even the benign growths often recur. The tumors must be removed completely, but the esophagus must not be perforated while doing this. Guthrie (1931) referred to a child, 8 months old, from whom a pedunculated, cystic swelling resembling a nasal polypus was removed from the upper esophagus by snaring.

Benign growths which cannot be removed through the esophagoscope rarely have caused symptoms of sufficient severity to justify external operation, but Ohsawa (1933) recorded the removal, by free left lower thoracotomy, of a myoma of the lowest portion of the esophageal wall. The patient was a Japanese woman, aged 43 years, who had suffered from dysphagia for twenty-four years. Following excision of the tumor, which was accomplished without opening the lumen of the esophagus, Ohsawa closed the muscle wall transversely. The patient experienced complete relief. Krauss (1933) reported from Sauerbruch's clinic in Berlin the removal of a nodular fibromyoma, the size of a small fist, from a man, aged 33 years, who had had dysphagia of increasing severity for three years. Roentgenograms showed a large, rounded, benign defect in the lower esophagus. The tumor was exposed by an abdominothoracic incision. The lumen of the esophagus was opened during the removal and was then sutured. Fearing a stricture, a short-circuiting esophagogastrostomy was added. Feedings were given temporarily by jejunostomy and recovery was rapid. Subsequent x-ray studies showed the anastomosis unnecessary and nonfunctioning.

Watson and Bancroft (1936) reported an instance of hypertrophic cricopharyngeal stenosis in a woman, aged 49 years, which, though entirely resistant to bouginage, was relieved by an extramucous incision, similar to the Ramstedt operation for hypertrophic pyloric stenosis. The pathologic picture was that of edema and fibrosis with hypertrophy and degeneration of the striated muscle fibers.

Wood (1932) demonstrated a specimen of esophagus, from a male, aged 69 years, which showed marked hypertrophy of the muscular wall in the lower third with narrowing of the lumen. The lesion was difficult to classify because microscopic sections showed no lesions in the muscle, ganglia, interstitial tissue, or mucous membrane. The possibility of vagus irritation as the cause of the hypertrophy might be considered.

(To be continued in the November and December Issues of the JOURNAL. *The references will accompany the last section.)*

Review of Recent Meetings

REPORT OF THE MEETING OF THE PACIFIC COAST ASSOCIATION, MARCH 28-31, 1939

H. H. Searls, M.D., San Francisco, Calif.

SUMNER EVERINGHAM, Oakland, Calif., gave, as the President's Address, **Our Responsibility in Graduate Surgical Training**, in which he urged that all surgeons give thought and attention to the training of our future surgeons for their responsibilities.

Frank W. Lynch, San Francisco, Calif., spoke on the subject, **Cancer of the Uterine Cervix After Radiation—A Histologic Study.** He showed the survival curve of his very complete series of patients with cancer of the uterus and cervix, with treatment. The treatment employed was radiation combined with operative removal. Follow-up studies were maintained for 100 per cent of the patients.

Robert Stone, San Francisco, Calif., discussing Dr. Lynch's paper, mentioned the biologic happenings which take place in a cell under radiation therapy. He congratulated Dr. Lynch on his excellent cooperation with the radiologists in the investigative phase of the treatment of cancer and urged all present to take this attitude. **James F. Rinehart**, San Francisco, Calif., pointed out that the amount of differentiation in the tumor is an index of its rate of growth, the more differentiated, the slower the growth. X-ray, besides destroying cancer, increases the differentiation of the cells and thereby slows its growth. **Raymond Watkins**, Portland, Ore., pointed out the value of radium therapy first in the treatment of carcinoma of the cervix because it causes the ulcer to heal and clears up the infection, thereby lowering the mortality rate when the Wertheim operation is done later. Dr. Lynch, in closing, said that as long as the profession as a whole remains radium-minded the women of the country are far safer than they would be if they were operated upon. He pointed out that, in his operations, he was taking only early cases in young women. He performs a radical operation as soon as the cancerous ulcer heals.

The Prognosis of Malignant Papillary Cystic Tumor of the Ovary was the title of the paper given by **Lewis B. Morton**, Los Angeles, Calif. The author presented sixteen cases of papillary cystic neoplasm of the ovary which, at operation, were proved malignant. These patients were operated upon at St. Vincent's Hospital, by various members of the staff, between the years 1930 and 1934, and their progress was followed. Eight of the sixteen are living and eight have died. A detailed report of all sixteen cases was presented and a final review made which indicated that the prognosis for the ultimate survival of patients with malignant cystic neoplasm of the ovary is uniformly bad. Owing to the absence of symptoms, the disease is well advanced before the patient comes to operation. In the higher grades of malignancy, when lymphatic metastases have occurred, recurrence is almost certain to develop. In the lower grades of

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malignancy, the outlook is far better, particularly if the tumor has not ruptured or metastasized. Even when these unfortunate events have occurred, there is hope for an occasional cure, or at least a prolongation of life.

In discussing Dr. Morton's paper, **Charles M. Fox,** San Diego, Calif., said that in his experience most of these tumors are decidedly malignant. He feels that aspiration of the cystic tumor is dangerous. **Otis Lamson,** Seattle, Wash., believes that, in operating for papillary cyst of the ovary, both ovaries and the uterus should be removed. He reported several cases.

Lemuel P. Adams, Oakland, Calif., showed a colored motion picture entitled **Behind the Scenes in a Modern Hospital.**

Speaking on **Acute Pancreatitis, E. Eric Larson,** Los Angeles, Calif., divided cases of acute pancreatitis into two types; one in which there is a transient acute attack with rather prompt recovery, and the other, the more severe and dangerous condition of autolysis known as hemorrhagic suppurative and necrotic pancreatitis, which is so rarely diagnosed except at operation or autopsy. The onset of both types of lesions is essentially the same, sudden severe pain in the epigastrium, radiating directly through the region of the upper lumbar spine and to either shoulder. There is a high leucocytosis with a varying degree of shock and cyanosis. Nausea and vomiting are usually present. At first these patients often have hypoglycemia from overproduction of insulin and later hyperglycemia from destruction of the islets in the pancreas. The measure of hyperglycemia may be considered a gauge for prognosis and treatment. No type of treatment will help those having severe hyperglycemia because the gland usually is destroyed completely. The decision as to the type of treatment must depend on an estimate of the severity of the disease. In the advanced cases the author believes abdominal operation with drainage of the pancreas offers the only chance for relief. He pointed out, however, that in many of the less advanced cases recovery takes place without surgery. He then reviewed the records of seventy-five cases of acute pancreatitis from the Los Angeles General Hospital. Forty-seven of these patients were operated upon with eighteen recoveries, a mortality of 61.7 per cent. Twenty-eight succumbed without operation and the true nature of the disease was not revealed until autopsy was done. The total mortality was 76 per cent. Though the etiology of acute pancreatitis is still not definitely known, orgies of food and liquor were discussed as possible etiologic factors and the author believes that they account for the higher incidence in the male than in the female. In his summary, Dr. Larson urged that more consideration be given to the possibility of acute pancreatitis when an acute abdominal condition is under observation.

In discussing Dr. Larson's paper, **George K. Rhodes,** San Francisco, Calif., mentioned the differential diagnosis between acute pancreatitis, acute perforation of the stomach or duodenum, acute obstruction of the gall bladder, and high obstruction of the bowel. He pointed out that the patient with acute fulminating pancreatitis has more shock and lower blood pressure than the patient with perforated ulcer or obstruction of the bowel. He advised frequent blood amylase readings. In discussing treatment, he said that conservative treatment is important until the patient recovers from the initial shock. He watches these patients carefully for the first four or five days, then, if a pancreatic cyst or abscess begins to develop, he believes in surgical intervention. In most cases the condition will subside; then the question arises as to the necessity for clearing up the chronic biliary disease which is present in probably 80 per cent of the cases. **William E. Kroger,** Los Angeles, Calif., said that, in his opinion, opera-

tion is indicated in most cases of acute pancreatitis. The type and degree of involvement, however, should be the determining factors in making important decisions as to whether or not to operate. **Conrad Jacobson,** Seattle, Wash., discussed the recent experimental work which has appeared in the literature. He pointed out that the prostration of these patients is away beyond that warranted by the clinical findings. He advised conservative treatment in most cases and said that, if a diagnosis is made of acute pancreatitis of the fulminating type, the condition is best left alone until it walls off.

Howard F. West and **Maurice Kahn,** Los Angeles, Calif., presented a paper on **Adenoma of the Pancreas** with hyperinsulinism; two cases in first cousins were reported, with surgical cure in one. Both patients were operated upon; in one an adenoma of the body of the pancreas was found and removed; in the other an adenoma of the head of the pancreas was not discovered until autopsy several months later. The authors observed that the symptoms of hypoglycemia, usually periodic or paroxysmal, are almost exclusively those of disturbed function of the autonomic or central nervous system. Symptoms frequently begin with vasomotor reactions indicative of sympathetic overactivity. The patient may present almost any conceivable psychic or motor misbehavior, ranging from mild euphoria to manic excitement, from mental depression to mental degeneracy, from transient weakness to paralysis, from muscular incoordination to convulsions. These symptoms are consistent with the diffuse damage found in the cells of the cerebral cortex and basal ganglia of patients who have died as a direct result of prolonged hypoglycemia. Because of this picture, these patients frequently are found on neuropsychiatric services before the correct diagnosis is made.

In discussion, **Charles T. Sturgeon,** Los Angeles, Calif., emphasized the need for a very thorough study of a patient before subjecting him to surgery when adenoma of the pancreas is suspected. He pointed out that removal of pancreatic tissue itself is not helpful and that, if the adenoma is not found and removed, the patient is not relieved. He discussed two cases in which no improvement followed the removal of part of the pancreas which did not include the tumor. **Emile F. Holman,** San Francisco, Calif., reported a case of the removal of a large portion of the pancreas without relief. **Robert D. Forbes,** Seattle, Wash., reported a case of adenoma of the pancreas and hyperinsulinism in his own practice. He could not feel the adenoma, but he removed about two-fifths of the body and tail of the pancreas and found the adenoma in the removed specimen. The patient was cured.

Alson R. Kilgore and **Glenn F. Cushman,** San Francisco, Calif., presented **Appendicostomy for Ulcerative Colitis.** The authors reported good results in ulcerative colitis by the use of appendicostomy.

J. H. Woolsey, Woodland, Calif., discussing the foregoing paper, said that he had thought that appendicostomy was obsolete, but that he was impressed by the findings of the authors and thought that he would have to use it again in the proper case of ulcerative colitis. **William J. Norris,** Los Angeles, Calif., suggested the use of partial cecectomy with eversion of the terminal ileum rather than appendicostomy for the treatment of ulcerative colitis.

Alfred O. Adams, Spokane, Wash., showed a motion picture illustrating the technique of the transplantation of full thickness and split thickness skin grafts.

In discussion, **J. H. Woolsey,** Woodland, Calif., emphasized the importance of immobilization of the graft once it was placed on the area to be covered.

Roscoe E. Mosiman, Seattle, Wash., in a paper entitled **The Significance of Subcutaneous Scar Tissue**, pointed out that the deformity with reduction of function in structures, resulting from the contractility of scar tissue, has become a major problem of modern surgery which has as its high ideal not only the healing of injury but also the restoration of structures to their normal condition as far as possible. In studying scar tissue carefully, the author noted that there were two types: (1) normal scar tissue with a complete healing process and (2) abnormal scar with continuing evidence of the irritation of tissue. The chief difference in the microscopic picture is that in the abnormal scar tissue there is an infiltration of mononuclear cells, collagen, and elastic fibers. As a result of the irritation of the tissue caused by mild residual infection, localized or fixed toxins, foreign or necrotic material, collagen and elastic fibers continue to form in the healing wound for a long period after it has been covered with epithelium. Contractility of the resultant bulk of scar tissue is more powerful than the muscle pull of the intervening joints, and deformity and loss of function result. At times there is a lack of formation of collagen fibers in the healing wound and this causes weakness and occasionally spontaneous rupture. Vitamin C is an aid to the proper formation of scar tissue. This has been proved experimentally and its absence may be the cause of the spontaneous rupture of wounds in surgical practice. It is important to minimize in every way possible the irritating factors in a wound so that the least amount of scar tissue may be deposited in the healed area. Reduction of trauma to the tissues, controlled hemorrhage in the wound, the use of nonirritating antiseptics and small amounts of suture material, complete asepsis, removal of dead tissue, and complete rest of the wound are the means used by the surgeon today to cut down reactions in the wound and thereby prevent the overabundant formation of scar tissue.

Homer D. Dudley, Seattle, Wash., as a discussant, called attention to the application of Dr. Mosiman's study to the practice of surgery and the treatment of wounds. **Emile F. Holman,** San Francisco, Calif., suggested that the use of vitamin C for three or four days before operation may help in the proper formation of collagen fibers and that vitamins A and B for the re-establishment of the red cells are also of value preoperatively. He urged the use of these three vitamins before operation.

Millard T. Nelsen, Tacoma, Wash., presenting a paper on **The Surgical Anatomy of Fistula-in-Ano,** gave a detailed description of the anatomy of the anal region, particularly that of the internal and external sphincters. In suggesting treatment of anal fistulas, he emphasized the need of prolonged Sitz baths. Bathing for hours each day many times will cure a patient for whom any other method is hopeless and may facilitate an otherwise difficult operative procedure. Incision should be radial from the rectal center, and Dr. Nelsen employs fistulectomy rather than fistulotomy. The two-stage procedure is necessary in deep fistulas in order to prevent incontinence; a silk ligature is tied loosely around the two sphincters and, after scar tissue has formed to back it up, the sphincters are transected, the scar tissue preventing incontinence.

Louis P. Gambee, Portland, Ore., commented on the ability of fistulous tracts in the upper gastrointestinal passages to heal, as contrasted with those in the rectum, which fail to heal.

Brien T. King, Seattle, Wash., reported **A New and Function-Restoring Operation for Bilateral Abductor Cord Paralysis.** He discussed at length the anatomy of this region, the pathologic anatomy following bilateral paralysis of the abductors of the vocal cords, and described a technique by which he has trans-

planted the omohyoid muscle into the muscular process of the arytenoid cartilage. He reported six cases in which excellent results had been obtained and showed motion pictures of the patients and of their vocal cords in motion after treatment.

Wallace I. Terry, San Francisco, Calif., suggested to Dr. King the use of a transverse incision of the skin instead of the one along the anterior border of the sternomastoid. He urged practice upon the cadaver of this operation, as Dr. King did, before attempting to perform it.

H. H. Searls, San Francisco, Calif., urged prophylaxis against the accident of bilateral palsy of the cords. **Leo Eloesser,** San Francisco, Calif., wondered how much of the relief obtained by the patient resulted from the severance of the posterior arytenoideus muscle.

A paper on **Abdominoperineal Resection for Carcinoma of the Rectum** was given by **Robert A. Scarborough** and **Emile F. Holman,** San Francisco, Calif. These authors reported a series of 95 consecutive cases, including both clinic patients hospitalized in the wards of Stanford University Hospital and private patients seen during the past four and one-half years. Four patients refused operation, though the condition was operable. Excision was performed in 69 of the remaining 91 cases, or 75.8 per cent. One operation was performed by the two-stage Lahey technique, there was one excision with end-to-end anastomosis, and in one case, local diathermy excision of a large malignant polyp was employed. These three patients are alive and well, four, three, and two years after operation. The remaining 66 patients were subjected to radical one-stage abdominoperineal resection, based on Miles' technique. There were 6 postoperative deaths, a mortality of 9.09 per cent. The authors emphasized the need of adequate preoperative preparation and discussed postoperative complications. They are of the opinion that the one-stage combined abdominoperineal resection is the ideal treatment for carcinoma of the rectum. This operation is not used to the exclusion of all other procedures, but they feel that any departure from it must be considered a concession to complicating circumstances which would render the operation unduly hazardous in the particular patient.

In discussion, **H. H. Searls,** San Francisco, Calif., pointed out that the more distally located carcinomas of the rectum can be removed by the Lockhart-Mummery technique and the more proximal ones by the Hartmann anterior abdominal resection. Abdominoperineal excision, therefore, may be avoided in most instances. The Hartmann procedure is less of an operation and therefore less shocking, leaves a good perineum, does not interfere with the nerve supply to the bladder, avoids the danger of impotence in the male, and carries a far lower mortality rate. **Leo Eloesser,** San Francisco, Calif., also gave as his opinion that the abdominoperineal operation is not necessary in all cases. A less radical operation often results in cure. In answer to the discussants, Dr. Scarborough said that he considered the operation to be indicated in every case of carcinoma of the rectum or rectosigmoid at any level and of any size, other than the small, pedunculated freely movable tumors.

In his paper **Valvular Drainage of Empyema by Means of a Skin Flap, Leo Eloesser,** San Francisco, Calif., described an operation by which a plastic skin flap or valve is made for the treatment of empyema. He pointed out that this flap operation, once done, requires no further care.

Frank S. Dolley, Los Angeles, Calif., reported, in discussion, that he had used the operation about twenty-five times and had found it of real value in certain

conditions, particularly in those cases of overwhelming toxicity associated with tuberculous empyema. **Ralph C. Matson,** Portland, Ore., commented that he had used the flap in a number of cases.

Thomas F. Mullen, San Francisco, Calif., presented **Safeguarding the Unconscious Operative Patient** in which he pointed out the dangers which must be anticipated and prevented during the time that the patient is asleep and unable to protect himself.

This paper was widely discussed by various members of the organization. **Thomas M. Joyce,** Portland, Ore., urged gentleness in handling tissues and care in the exploration of the abdomen. He pointed out the tremendous progress in anesthesiology. **P. W. Willis,** Seattle, Wash., suggested the use of a thermometer to safeguard against overheating of the saline solution from which sponges used in the abdominal cavity are wrung. **H. G. Wetherill,** Monterey, Calif., pointed out some of the dangers of operating in higher altitudes. **Frank S. Dolley,** Los Angeles, Calif., mentioned that traction on the arm with the patient asleep may result in ulnar paralysis. **A. R. Kilgore,** San Francisco, Calif., urged the abolition of packs from abdominal surgery. **Dexter Richards,** Oakland, Calif., warned against the use of ether in the preparation of the skin before an operation which involved the use of the cautery because the ether may run down into the sheets, evaporate, and cause an explosion. In closing, Dr. Mullen left the thought that the surgeon, and the surgeon only, is the guardian of the patient's safety.

Paul G. Flothow, Seattle Wash., in **Advances and Retreats in Neurosurgery** discussed the history of the development of neurosurgery, and detailed the modern aids to neurosurgical diagnosis and advances in surgical technique, together with the development of new instruments especially designed for neurosurgical work. He then discussed the various conditions which the neurosurgeon treats.

Frederick L. Reichert, San Francisco, Calif., noted the importance of Dr. Flothow's paper in taking stock of what has been accomplished in the development of neurosurgery.

THE TWENTY-SECOND ANNUAL MEETING OF THE AMERICAN ASSOCIATION FOR THORACIC SURGERY, JULY 5, 6, and 7, 1939*

JOSEPH W. GALE, M.D., MADISON, WIS.

THE twenty-second annual meeting of the American Association for Thoracic Surgery was held in Los Angeles, Calif., July 5, 6, and 7, 1939, with headquarters at the Ambassador Hotel.

The program committee succeeded in producing a most interesting group of papers which were in each instance original and very instructive.

The local committee on arrangements, consisting of **J. J. Singer, Frank S. Dolley,** and **John C. Jones,** provided most excellent entertainment and saw to it that all members of the association and guests were made to feel that the far West was glad to act as hosts to the organization.

Benign Chondroma of the Chest Wall, Fred R. Harper, Denver, Colo.—The author stated that these tumors are not rare, even though they have not been reported in large numbers. Approximately sixty cases were collected from the literature and two added in this paper. These tumors have a tendency to recur as a malignant tumor. They grow insidiously over a long period of time and are usually discovered accidentally. The origin is not clear, but they may appear from islands of fetal cartilagenous rests, postrachitic cartilagenous islands, or trauma. The treatment as given by the author consists in early complete removal of the tumor using the type of incision to fit the particular case.

Primary Tumors of the Ribs, Robert M. James, Toronto, Ontario.—The author added eight new cases of primary tumors of the ribs to the literature. The diagnosis and classification of these tumors as they appear in the literature is misleading. The necessity of a tumor registry was cited. He advised early and complete removal to prevent recurrences in the form of a malignant tumor. In the discussion the similarity between tumor of the rib and those of the intercostal nerves was brought out; also the mistake in diagnosis of such tumors, confusing them with inflammatory lesions occurring in the ribs in the form of a typhoid osteomyelitis. The surgical approach to these tumors was also discussed.

Pectus Excavatum, A. Lincoln Brown, San Francisco, Calif. (by invitation).—Seven cases were reported, all of which seemed to be on an hereditary basis. In the author's experience simple removal of the depressed sternum did not correct the deformity. The condition appears to be brought about by the activity of the diaphragm. This was demonstrated following the removal of the sternum by the presence of a dense substernal ligament. After division of this ligament there was marked separation and the deformity disappeared obviating the chances of recurrence. The operative procedure, which included section of the anterior attachments of the diaphragm to the gladiolus and with the substernal ligaments at the level of the junctions of the xiphoid and gladiolus, was described as particularly effective to arrest the development of the deformity of pectus excavatum in young children.

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*The articles abstracted here will appear in entirety in subsequent issues of the *Journal of Thoracic Surgery.*

Primary Tumors of the Diaphragm, Joseph W. Gale and (by invitation) **Stanley R. Edwards,** Madison, Wis.—The occurrence of primary tumors of the diaphragm has been found to be extremely rare. Only twelve cases have been previously reported. Eight of these were malignant, four were benign. The methods of diagnosis, including artificial pneumothorax and pneumoperitoneum, with the description of their particular value in isolating the diaphragm from the surrounding structures, was discussed. The successful removal of a malignant tumor in the right hemidiaphragm was reported. This patient had remained free from recurrence for twelve months.

In the discussion **Thomas Kinsella,** Minneapolis, Minn., reported the removal of a large benign tumor of the diaphragm. **Ethan F. Butler,** Ithaca, N. Y., also reported the removal of a cyst of the diaphragm.

Removal of Teratoma From the Anterior Mediastinum, Stuart W. Harrington, Rochester, Minn. (movie).—The cinema dealt with the removal of tumors of the thorax and mediastinum. The author feels that the posterolateral incision and transpleural removal of anteriorly placed tumors is the operation of choice. The technique employed in the removal of intrapulmonary and mediastinal tumors also was demonstrated beautifully.

Pulmonary Ventilation and Anesthesia in Major Chest Surgery, Clarence Crafoord, Stockholm, Sweden (guest speaker).—The author gave a detailed discussion on the alterations in physiology occurring in the presence of an open pneumothorax mentioning in particular the difficulty of adequate oxygen exchange in these cases. He described the machine which he had developed with which it was possible to produce a rhythmic insufflation of the lungs in the presence of an open pneumothorax, which permitted an increased tidal volume while using nitrous oxide as an anesthetic agent. Nitrous oxide is preferred because of its lack of irritation to the respiratory system, the few tracheobronchial complications, the lack of shift of the mediastinum, the small amount of shock, and the adequate time allowed for meticulous care in performing the operation, particularly in closure of the bronchial stump following pneumonectomy.

Differential Pressure and Reduced Lung Function in Intrathoracic Operations, W. E. Adams, Chicago, Ill.—Experimental and clinical evidence was presented to demonstrate the hazards associated with some of the methods employed at the present time in maintaining differential pressure within the tracheobronchial tree. The relationship between high intrabronchial pressure and pneumothorax was discussed and demonstrated along with the resultant mediastinal emphysema which occurred in experimental animals with the use of a too high intrabronchial pressure.

Further Studies of Survival Following the Maintenance of Life During Experimental Occlusion of the Pulmonary Artery, John H. Gibbon, Jr., Philadelphia, Pa.—The author described the methods employed in animals whereby life could be maintained by clamping the pulmonary artery and stopping the flow of blood completely in the lungs, at the same time withdrawing blood from a peripheral vein, introducing oxygen into this media, and returning it as oxygenated blood to the animal's arterial system through a peripheral artery. The results of these experiments performed on cats were described. Animals which were deprived of their blood for thirteen minutes without the replacement of oxygenated blood showed advanced cerebral changes, while the animals in which the blood was removed, oxygenated, and replaced survived after eighteen minutes without evidence of cerebral changes.

Hemicardiac Hypertrophy and Enlargement Solely Due to Increased Peripheral Resistance: A Study of Pulmonic and Aortic Stenosis Experimentally Produced, Emile Holman, San Francisco, Calif.—Small puppies ranging in age from ten days to six weeks were operated upon, the aorta and pulmonary artery being partially ligated just beyond the heart. The development of changes in the heart was followed by x-ray and necropsy studies with a comparison of the experimental animals and their hearts with their litter mates as controls. Arterial aortic stenosis produced a marked hypertrophy of the left ventricle as compared with controlled animals. Stenosis of the pulmonic artery produced a hypertrophy of the right ventricle. The control animals developed more rapidly than their litter mates. These results were compared with the dilatation that occurred in the presence of the arteriovenous fistula.

Factors Affecting the Regeneration of the Lung, Roy Cohn, San Francisco, Calif., (by invitation).—Different amounts of lung tissue were removel from rats. In all except old rats the original weight of the remaining lung tissue was restored within two weeks. The change in weight of the remaining lung tissue was dependent upon the size of the remaining thoracic cage. The effect of plombage, phrenic block, and high altitude on the weight of the lung was discussed. The heart weight was increased in all cases up to 40 per cent. No proof of cause of increase in weight was found. Alveolar counts showed no increase in the number, but the author thought the increase was very likely due to a thickening of the alveolar walls and an increase in the perivascular connective tissue.

A Selective Type of Thoracoplasty Operation, William A. Hudson, Detroit, Mich.—The author gave his experience of five years with a different type of thoracoplasty. The method included, first, the anterior removal of a greater part of the first two ribs, plus the lysis of the pleural attachment along the anterior mediastinum and vertebral gutter. This was followed by a second operation, at which time the posterior segments were removed through a paravertebral incision. The author states specifically that although the lysis was carried out around the apex, the tip of the apex was left suspended by the fibers of Sibson's fascia so that the collapsed lung assumed a narrow conical appearance in the chest.

The End Results of 511 Thoracoplasty Patients, E. J. O'Brien, Detroit, Mich.—The author stated his hope that thoracoplasty would be unnecessary in the future and that it may be successfully prevented by early adequate medical care. He also stated that every thoracoplasty patient was a challenge to medical treatment. The results of different types of thoracoplasty operations along with early and late mortality were discussed. The productive lesion cases showed early mortality in this series of 9 per cent plus, while the exudative cases showed a slightly higher mortality, 12 per cent. The cardiorespiratory reserve, the conversion of sputum, and the rehabilitation of these patients were given particular attention in the discussion.

Extrafascial Air as an Adjunct to Thoracoplasty With Extrafascial Apicolysis, T. B. Aycock and (by invitation) **Otto C. Brantigan and Hugh Welch,** Baltimore, Md.—Thirty-six cases of Semb apicolysis were reported in which air was introduced to fill the overlying dead space created by the apicolysis. This was preferred by the authors to fluid. Air refills were continued until the rib regenerated with sufficient stability to hold the apex in the collapse position. They felt that

the injection of air in certain instances might do away with the necessity of another stage of thoracoplasty in certain cases due to the ability of air to hold the lysed apex in a position which was gained at the time of operation.

Planography (Body Section Radiography) as Applied Especially to Pulmonary Disease, Warren C. Breidenbach, Dayton, Ohio (by invitation).—A description of the present methods of application and the advantages in spotting the location, depth, and size of cavities or new growths involving the lung were given.

Four Years' Experience With Extrapleural Pneumooleothorax, Oscar S. Proctor, Setttle, Wash.—The author was probably the first in the United States to employ the use of extrapleural pneumothorax since his cases included a follow-up of four years. The technique of the procedure of extrapleural pneumothorax was again described. Oleothorax was used in these cases after all fluid had been aspirated from the extrapleural cavity and it was considered dry and clean and the desired collapse had been obtained. Some of these cases had been observed as long as four years. In the author's experience he found that only small refills of oil were necessary every six to twelve months once the oleothorax was properly established. No serious complications were encountered following the use of oil. No bronchial fistulas had developed allowing the oil to escape in the tracheobronchial tree. Olive oil with a 2 per cent gomenol was used in all cases. A small amount of oil was introduced first to determine the susceptibility of the patient to the oil. If no untoward reaction occurred, the extrapleural cavity was rapidly filled.

Presidential Address, Harold Brunn, San Francisco, Calif.—Two interesting pulmonary tumors were presented. These arose in the lung parenchyma. They carried several pathologic diagnoses and brought up the question which is vital to the clinician; namely, "what to do with such tumors when there is a disagreement as to the degree of malignancy present." In one instance the tumor was excised. In the second instance the author performed a lobectomy. He stated that had the nature of these tumors been better understood the treatment in the two tumors might have been absolutely reversed. Note was also made of the fact that the x-ray appearance of these tumors was identical. Furthermore, the author stated the necessity of a tumor registry whereby these tumors could be more closely studied and a follow-up of such cases be carried out for a sufficient length of time to give the clinician a criterion to go by as to the operative procedure to employ in the treatment of these tumors.

A Comparative Report on Infection of Thoracoplasty Wounds: Experience With the Ultraviolet Irradiation of the Operating Room Air, Richard H. Overholt and (by invitation) **Reeve H. Betts,** Boston, Mass.—The report concerned infection occurring in 411 cases of thoracoplasty done over a period of two and one-half years, following the use of ultraviolet irradiation checked by previous tests to determine its efficiency during and following voluntary air contamination. It was found to be highly bactericidal. The authors employed a light, placing two lights at the junction between the ceiling and wall of the operating room so that a cross-ray was thrown downward to the patient and into the wound. By keeping the light in this elevated position, there was less danger of burning the operating room personnel and less protection to the eyes and exposed skin surfaces was found to be necessary. In the group of cases reported following this new type of treatment and a new method of wound closure, the incidence of infection was reduced from 6.53 per cent to 0.48 per cent.

Polypoid Bronchial Tumors, H. Brodie Stephens and (by invitation) **Alfred Goldman,** San Francisco, Calif.—Three types of tumor were described: (1) endobronchial, (2) intramural, (3) endoextrabronchial. The distinguishing characteristics of bronchial adenomas on the one hand from the metastasizing carcinomatous polypoid tumors, as well as from the benign polypoid tumors endowed with the least growing potentialities, and the difficulties in making the diagnosis were given. This led to the very different decisions as to the type of procedure to follow in the removal of such tumors. Bronchiogenic removal was deemed ill advised in such cases where there was evidence of invasion into the peribronchial tissues. The discussion of lobectomy and pneumonectomy and the choice of either method could not be settled definitely until the pathologists could be brought to an agreement on the classification of these growths; namely, as to whether they were benign or malignant. Furthermore, the thoracic surgeon will have to have further experience to determine through follow-ups and final check of such patients before the correct method of treatment can be determined.

The Diagnosis and Surgical Therapy of Patent Ductus Arteriosus, John C. Jones, F. S. Dolley, and (by invitation) **Lewis T. Bullock,** Los Angeles, Calif.—Seven cases of patent ductus arteriosus operated upon were reported. A movie film was shown giving the detail of operative technique. Attention was drawn to the necessity of a correct diagnosis by pathognomonic signs and symptoms encountered in these cases. The danger of attempting the procedure in the presence of coarctation of the aorta and other congenital abnormalities was discussed along with the difficulties of the operative procedure once a correct diagnosis had been made.

Operations for Development of Collateral Circulation to the Heart, Peter Heinbecker and (by invitation) **Wesley A. Barton,** St. Louis, Mo.—An experimental study was made on sixty dogs upon which a pericardotomy was done. The pericardium once opened was desensitized with novocain, following which a solution of aleuronate plus 0.5 per cent sodium morrhuate was injected into the pericardial sac. The opening in the sac was then closed and it was sutured to the retrosternal structures. Observations made on these animals three and sixteen weeks later showed the presence of fibrous adhesions between the heart and pericardial wall. These adhesions were injected by a special technique which showed definitely that they contained new blood vessels. This was thought by the author to be applicable to clinical surgery.

Dorsal Sympathetic Ganglionectomy for Intractable Asthma, Duane Carr, Memphis, Tenn.—The author gave a brief résumé of the voluminous literature on this subject, mentioning the points of disagreement regarding the disease. He also reported three patients upon whom he had done a bilateral resection of the third and fourth dorsal sympathetic ganglia. Favorable results were obtained in two of these cases. The third was apparently unsuccessful because the "trigger area" does not always lie in the bronchial mucosa. His description of the technique of exposing the sympathetic ganglia by the extrapleural approach was given and its advantages over other approaches. These operations were performed under local anesthesia without any undue discomfort to the patient.

Large Infected Pulmonary Cysts Simulating Empyema, Herman C. Maier, New York, N. Y., and **Cameron Haight,** Ann Arbor, Mich.—The authors stated that the mistake in diagnosis of large infected pulmonary cysts was not infrequent and that they were often treated as encapsulated empyema rather than as cysts. A close study of the type of secretion obtained from these cavities at the time

of operation, the persistence of the cavity, and the lack of such clinical manifestations as high fever and signs of chronic pulmonary suppuration should lead one's curiosity to be aroused to such an extent as to become suspicious of the presence of such cysts. The two groups of cysts which occur most commonly were demonstrated; namely, those lined with epithelium and those without; also the congenital and acquired types. In the treatment the author stated that collapse procedures were contraindicated, simple drainage procedures would not correct the condition, but the only satisfactory method was removal of the cyst lining.

Acute Putrid Abscess of the Lung, Harold Neuhof and **Arthur Touroff,** New York, N. Y.—The authors reported eighty-four cases of acute putrid lung abscess, stating the indications for operation, the type of operation to be employed, and the operative results. Three deaths occurred in this group of patients. The authors feel that early operation is to be preferred, preferably a one-stage procedure if possible.

Joint Manifestations Associated With Lung Tumor, Willard Van Hazel, Chicago, Ill.—The author reported seven cases. Five were malignant and two were benign. All of these patients were without lung symptoms. In each case there was a hypertrophic pulmonary osteoarthropathy accompanied by great disability. In two of these cases there was a complete disappearance of symptoms following pneumonectomy for bronchiogenic carcinoma. In one instance the removal of a large intrathoracic fibroma resulted in the abatement of symptoms.

Book Reviews

Varicose Veins. By Alton Ochsner, M.D., and Howard Mahorner, M.D. Cloth. Pp. 147, with 50 illustrations and 2 color plates. St. Louis, 1939, The C. V. Mosby Company. $3.

In this excellent monograph the authors have covered in a comprehensive manner the subject of varicosities of the lower extremities. The various aspects of the subject, such as history of treatment, anatomy, pathology, physiology, etc., are presented in separate chapters. For this reason the book is well suited to serve as a reference book for both the student and practitioner.

In the chapter entitled "Examination of the Varicose Vein Patient," the various tests and methods of examination are critically discussed from the standpoint of anatomy and physiology. The comparative tourniquet test, which is the contribution of the authors, is carefully described and the value of this test in the treatment of varicose veins is indicated.

The chapter on treatment is particularly worth while. The authors have drawn widely on their own wide clinical and experimental observations. The views they express are conservative, well founded, and orthodox.

There is little that one can criticize. Illustrations, both photographs and diagrams, are ample and well chosen. Much of the material presented has been published previously in the various surgical journals, but this fact in no way detracts from the value of the present publication. Since a short chapter on the treatment of varicose ulcers has been included, one wonders if this portion of the work might not have been expanded with profit beyond its allotted three pages. An excellent bibliography and index are appended.

Praktische Anatomie. By T. von Lanz, Professor of Anatomy, University of Munich, and W. Wachsmuth, Instructor in Surgery, University of Bonn. Vol. I, Part 3. Cloth. Pp. 276, with 208 illustrations largely in color. Berlin, 1935, Julius Springer. R.M. 29. Vol. I, Part 4. Bein und Statik. Pp. 485, with 342 illustrations, largely in color. Berlin, 1938, Julius Springer. R.M. 29.

These extraordinary tomes by Lanz, Assistant Professor of Anatomy at Munich, and Wachsmuth, Instructor in Surgery at Bonn, are without question two of the finest volumes on practical gross anatomy that have ever been published. In their preface to the first volume the authors set themselves the "task of composing a work in anatomy that will bring honor to German medicine from the entire world." If the volumes to follow preserve the high standard set by these two, the objectives of the authors will not miss their mark.

For sheer beauty of artistic reproduction of dissections, the volumes are alone remarkable. Pictures that are a real pleasure for the eye to gaze upon and study occupy almost every page of each volume. There are illustrations in color of large regional dissections, cross sections, and surgical approaches and exposures. It seems most unusual that the authors failed to mention the names of the artists whose work contributed so much to the success of this enterprise.

To be sure, the illustrations constitute the most illuminating portion of these volumes. Yet, the general plan of the book in itself is excellent. An intimate collaboration of anatomist and surgeon has resulted in volumes which will appeal particularly to surgeons. A special feature is the listing of the frequency of anomalies. Developmental osseous anatomy also receives consideration. A particular feature of the second volume is the graphic reproduction of the range of joint motion with the apposed members in various positions. Well-selected bibliographic references accompany each volume.

Surgeons who delight in holding fine books in their hands and thrill at the sight of beautiful illustrations will hasten to add these volumes to their library. Those responsible for the teaching of applied anatomy in medical schools will find the volumes useful.

Textbook of Healthful Living. By Harold S. Diehl, M.D., Dean of Medical Sciences, University of Minnesota Medical School, Minneapolis. Cloth. Ed. 2. Pp. 634, with 63 illustrations. New York, 1939, McGraw-Hill Book Company. $2.50.

This is a revised and enlarged edition of a book that has already earned very deserved recognition, both as a class text on personal hygiene and as a popular volume for the adult lay reader who seeks authentic information on health. The author has made a conscious effort to present a conservative point of view, being cautious to avoid creating false hopes and reserved in his estimates as to the possible attainments from various procedures for health maintenance. He assumes that his reader wants to know the truth rather than to be deceived by extravagant promises. In this respect the book offers a refreshing contrast from certain of the popular health "literature." Fads have been treated sympathetically yet without sacrifice of critical analysis; frauds have been mercilessly and frankly exposed. The author has enriched the text by an almost lavish use of reference material and quotations. In addition to being a most readable text, the volume contains a surprising amount of factual data which make it of added value as a reference book for the student of personal hygiene. The new edition has been enlarged by the addition of chapters on parenthood and community organizations for the protection of public health. This book can be highly recommended to anyone who seeks a sane and tempered discussion of healthful living.

The Circulation of the Brain and Spinal Cord (A Symposium on Blood Supply). By Editorial Board: Stanley Cobb, M.D., Angus M. Frantz, M.D., Wilder Penfield, M.D., and Henry A. Riley, M.D. Cloth. Pp. 313, with 120 illustrations. Baltimore, 1939, Williams and Wilkins Company. $10.

This book contains the Proceedings of the 1937 Meeting of the Association for Research in Nervous and Mental Diseases. It is the eighteenth volume of such proceedings which have been published annually since 1920, each meeting having been devoted to a symposium on some phase of nervous and mental disease. The contributors to each volume are from laboratories and clinics which have been conducting researches on the subject under discussion. The current issue contains thirty-six chapters, or individual papers, by thirty-six different authors. These are grouped according to subject in the following sections: I. Anatomy and Physiology; II. Pathology; III. Clinical Contributions. In the final chapter

Cobb summarizes and discusses the most important recent advances in cerebral circulation. This chapter by Cobb will be read with much profit by anyone interested in nervous and mental diseases. The rest of the book is of value mostly as a reference work and is an indispensable reference for those engaged in research pertaining to circulation of the brain and spinal cord. Each chapter is accompanied by a bibliography. Most of these bibliographies are of good form and very extensive. There are many well-reproduced illustrations and a twenty-eight-page index.

This volume is indispensable for reference libraries.

Pathologische Physiologie Chirurgischer Erkrankungen (Experimentelle Chirurgie). By Franz Rost, M.D. (Deceased), and Th. Naegeli, M.D., University of Bonn, Germany. Paper. Ed. 1. Pp. 375, with no illustrations. Berlin, 1938, Julius Springer. R.M. 31.50.

Franz Rost's pathologic physiology of surgical diseases became well known to American students of surgery through the translation by Stanley Reimann of Philadelphia. More than a decade has elapsed since the publication of the third edition of the late Professor Rost's work upon which that translation was based. It is timely that a revision of this splendid source book be undertaken, and it is most gratifying to find that a portion of the new fourth edition is already in print. An enlarged edition of Rost's work is to appear under the editorship of Naegeli, of Bonn. In this undertaking he is to have as collaborators Kessel, Merke, and Meythaler, well-known German and Swiss surgeons.

The first volume concerning the alimentary canal and its appendages appears herewith. Naegeli has written most of the chapters. Those on the pancreas, liver, and biliary passages are written by Meythaler.

Though most of the references and discussions relate to work of German authors; nevertheless, the book is, as were earlier editions of Rost's work, one of the most valuable source books extant on the subjects under discussion. In a few instances the discussions are somewhat sketchy, but in the main all are very well done. Any surgeon can read the sections on ulcer, bowel obstruction, the liver, biliary passages, and pancreas with much profit. This volume should find favor with surgeons everywhere. It is a scholarly piece of work and constitutes the best available single reference book on the physiologic pathology of surgical diseases of the digestive tract. It is to be hoped that a translation will be made generally available for English-speaking surgeons.